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VOL. 37 JANUARY 1952 FASC. 1

ROENTGENOGRAPHIC SIGNS OF TUMOR INFILTRATION OF THE WALL OF THE URINARY BLADDER

by

C. Franksson and *K. Lindblom*

In order to plan a surgical approach to growths of the urinary bladder it is important to know the extent and degree of invasion of the tumors.

Epithelial tumors of the urinary bladder invading the walls may be divided into three main groups:

1. Tumors growing only in the mucosa.
2. Tumors invading the mucosa as well as the submucosa.
3. Tumors infiltrating all the layers of the bladder wall.

Fig. 1. Non-infiltrating papilloma of left bladder wall. No thickening of the wall in region of tumor.

Fig. 2. Infiltrating carcinoma on right side; lymph node metastases were found at operation. Diffuse thickening of bladder wall upwards and to the right.

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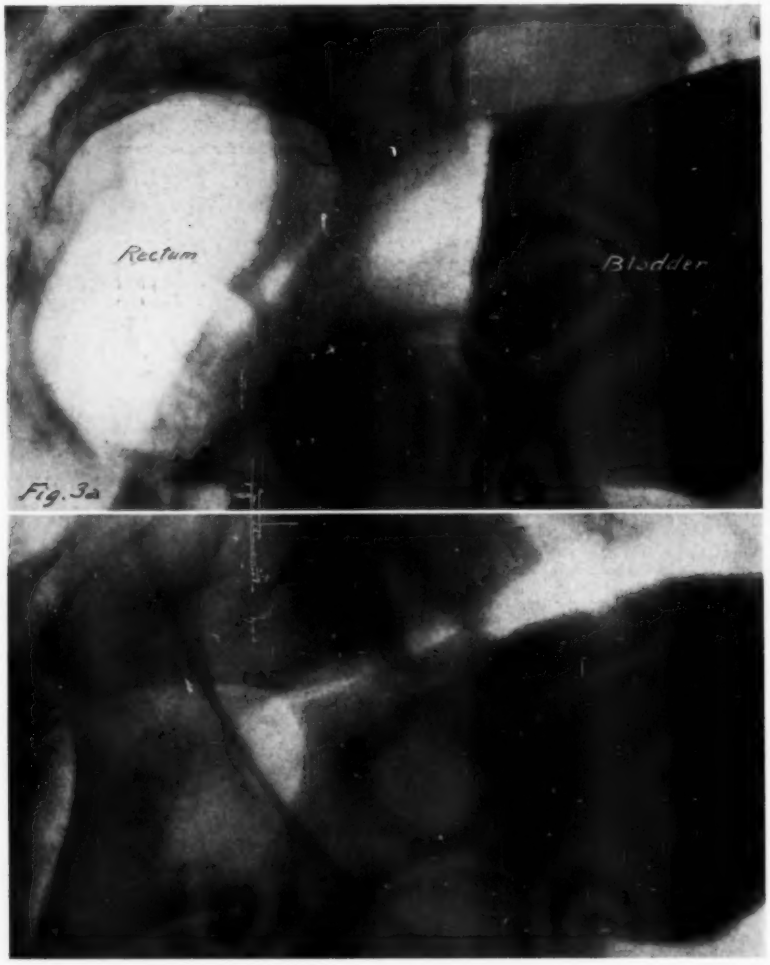


Fig. 3 a—b. Inoperable carcinoma in posterior wall of bladder. Cystogram (a) demonstrated tumor (×); by pneumoperitoneum in prone position (b) the gas was held up anterior to the tumor region (↓) and did not pass into the fossa Douglasi.

In the first group adequate surgical treatment is, as a rule, possible by transurethral approach. In the other two groups suprapubic incision with resection of the bladder wall or cystectomy is necessary.

Submucous infiltration was only rarely detected on manual palpation

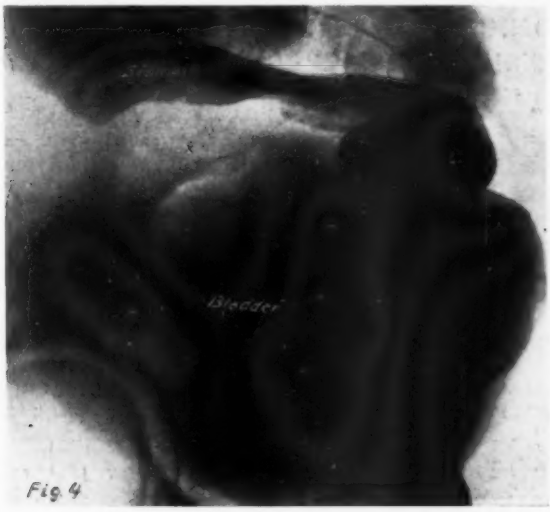


Fig. 4. Infiltrating urachus tumor. Cystograms demonstrated tumor at vertex of bladder; extravesical tumor (×) bulging into sigmoid was demonstrated by barium enema.

as a hardening and thickening of the bladder wall. Further in many cases of deep infiltration these signs could not be elicited by palpation. The cystoscopic appearance of the tumor and its surroundings was often helpful, but there still remained many cases in which the question of the extent of invasion could not be determined.

The purpose of this paper is to show the additional information which may be obtained by roentgenography on the degree of tumor invasion. It includes a study of the thickness of the bladder wall in the region of the tumor as well as of the emptying of the ureters.

Material

The material consists of 434 cases of bladder tumors treated in the surgical department of the hospital during 1940—1948 (see FRANKSSON). Cystography was earlier performed only occasionally. For this reason the number of cases cystographed is only 117. Excretory urography was carried out in 229 cases. Both cystography and urography are performed nowadays in the majority of the cases of bladder tumors.

Fig. 5 a—b. Bladder carcinoma in lower part of anterior wall with perivesical growth. A tumor bulging moderately into the lumen shown by cystography; the perivesical part of tumor (×) was visualized by the injection of perabrodil into the prevesical fat.

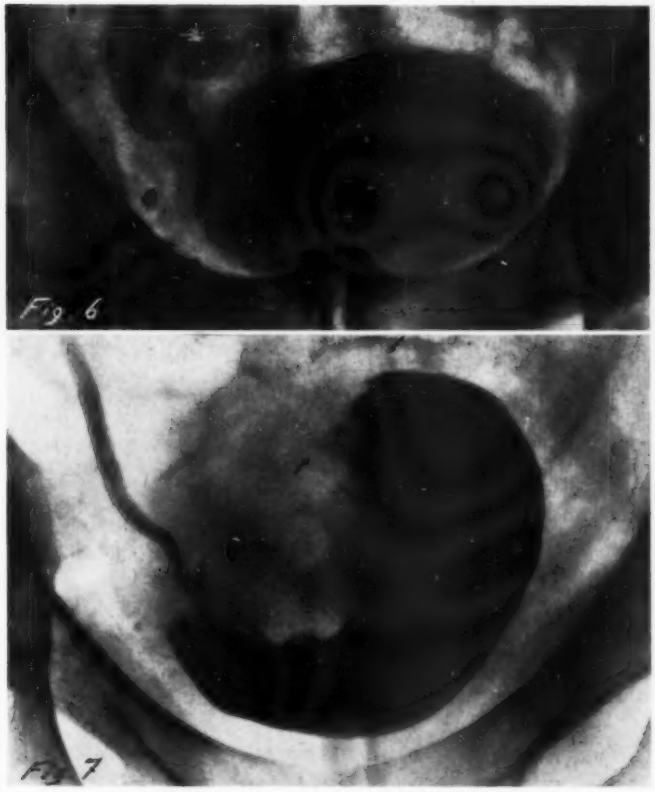
The cystographic determination of the thickness of the bladder wall

The following table demonstrates the number of cases in which the bladder wall was visible in the region of the tumor.

Depth of growth	Outer outline of bladder visible		Outer bladder contour ends at tumor	Outer contour not visible at tumor
	Thickened	Not thickened		
Mucosa	—	16	1	14
Submucosa	7	—	3	5
Muscle	9	—	1	11
Perivesical tissue	13	—	1	13
Unknown benign	—	3	—	4
Unknown malignant	6	1	1	8
Total	35	20	7	55

In most cases of a visible outer outline of the bladder the tumor was situated in the upper or lateral part of the wall. A definite thickening of the wall occurred only in cases of tumors infiltrating the submucosa or deeper. No thickening of the wall indicated a tumor in the mucosa only.

The thickness of the wall could be determined in most cases in the upper or lateral part of the bladder. This was carried out by studying the subperitoneal layer of fat on ordinary cystograms in which the bladder was moderately distended. (Figs. 1—2.) In a few cases, a tumor mass bulging into the peritoneal cavity could be demonstrated by outlining the peritoneal surface of the bladder (pneumoperitoneum; Fig. 3 a—b), by pelvigraphy with a peritoneal injection of perabrodil mixed

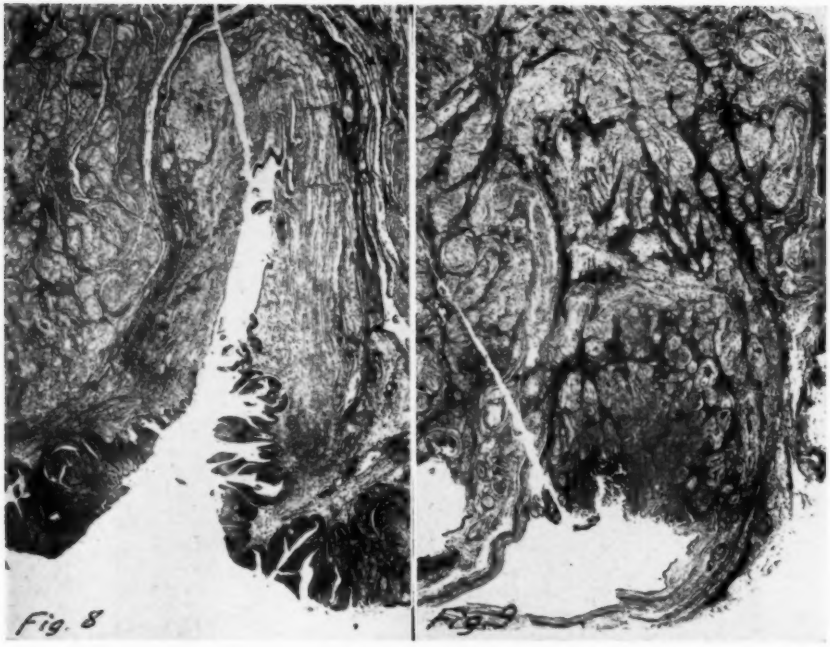


Figs. 6—7. Two cases of infiltrating carcinoma partially blocking right ureter. At ↓ in Fig. 7 infiltration of bladder wall is also demonstrated by the elevation of margin of tumor.

with novocain, or by distension of the sigmoid colon with air or barium (Fig. 4).

Tumors in the anterior wall of the bladder were studied directly, aided by the outline between the bladder wall and the prevesical fat or indirectly by infiltration of the prevesical fat with 35 % perabrodil and 1 % novocain (Fig. 5 a—b).

In those cases in which the external contour of the wall of bladder was not visualized, a roentgenographic diagnosis of infiltration could usually be made by examining the internal contour adjacent to the tumor. If this outline were elevated and then gradually returned to the normal (Fig. 7), a definite sign of, at least submucosal, infiltration was



Figs. 8—9. Microphotographs of longitudinal sections of two ureteric orifices; left: nonblocking benign papilloma; right: carcinoma invading ureter.

considered to be present. In cases of tumors which did not bulge to any marked degree into the bladder, a displacement of the lumen of the bladder to the opposite side was a sign of an extensive invasion of the wall. Accompanying edema was partly responsible for the displacement of the lumen in one of these cases.

No attempt was made to study the position and shape of the seminal vesicles in this series. Such a study may be of value in cases of tumors at the base of the bladder where an outlining fat layer is missing.

The urographic study of the ureters

Out of the 229 cases examined by urography a dilatation of one or both ureters or an absence of excretion was found in 58 cases. Only occasionally did a tumor, limited to the mucosa, cause dilatation of the ureters. The large majority of the cases with dilated ureters showed deeply infiltrating tumors (Figs. 6—7).

Histological studies demonstrated that a benign tumor of the bladder mucosa had little tendency to involve the mucosa of an adjacent ureter. (Fig. 8.) On the contrary, malignant tumors did not respect the ureteric wall, but narrowed the lumen of the ureter by growing into the wall and by periureteral infiltration (Fig. 9).

SUMMARY

A roentgenographic examination of the bladder wall and the ureters gives valuable information as to whether a bladder tumor is infiltrating deeply or growing superficially in the mucosa. This information is a valuable complement to an ordinary clinical examination in order to determine operability and surgical approach.

ZUSAMMENFASSUNG

Die Röntgenuntersuchung der Blasenwand und der Harnleiter gibt wertvolle Aufschlüsse darüber, ob ein Blasentumor tief infiltriert oder oberflächlich intramukös wächst. Diese Aufschlüsse ergänzen in wertvoller Weise die Resultate der gewöhnlichen klinischen Untersuchungen zur Bestimmung der Operabilität und des Operationsweges.

RÉSUMÉ

Un examen radiologique de la paroi vésicale et des uretères donne des renseignements importants sur l'étendue d'une tumeur vésicale. Il est possible de savoir si elle intéresse les couches profondes ou si elle se limite à la muqueuse. Ces données complètent utilement l'examen clinique courant et permettent de juger de l'opérabilité et de la voie d'accès.

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PULMONARY CHANGES IN CASES OF DISSEMINATED LUPUS ERYTHEMATOSUS

by

Ivan Thorell

MONTGOMERY and MCCREIGHT presented in 1949 an analysis of cases of disseminated lupus erythematosus seen at the Mayo Clinic up to 1948: 154 cases up to 1938 and 132 cases from 1938 to 1947. The cases were classified as chronic, subacute and acute. The authors stated that disseminated lupus erythematosus, especially of the acute and subacute type must be regarded as a systemic disease.

In 1942, RAKOV and TAYLOR published a case without cutaneous manifestations and with long-continued consolidation at the bases of the lungs and reviewed cases described by OSLER and by TREMAINE. They wrote: »Only rarely has an observer appreciated that pulmonary parenchymal lesions are specifically a part of the visceral manifestations of this disease.» They point out that chronic consolidation of the lungs suggests that the pulmonary changes are an integral part of the disease, comparable to those encountered in the other viscera.

In the literature, pleurisy is stated to be the most frequently occurring pulmonary change in cases of disseminated lupus erythematosus.

In REIFENSTEIN's collocation (1939) comprising 18 cases (reviewed by HOLTEN in 1943 and ADAMSON in 1947) pleurisy always occurs at one phase or another of the disease. THYRESSON reported (1944) that pleurisy is usual. BAEHR and POLLACK (1947) stated that dry pleurisy is frequently observed during exacerbations. Changes in the lung parenchyma have also been demonstrated. RAKOV and TAYLOR (1942) observed parenchymal changes which they interpreted as atelectasis of the lower lobes. THYRESSON (1944) described a case showing parenchymal changes in the left lower lobe, probably due to a pneumonic residue.

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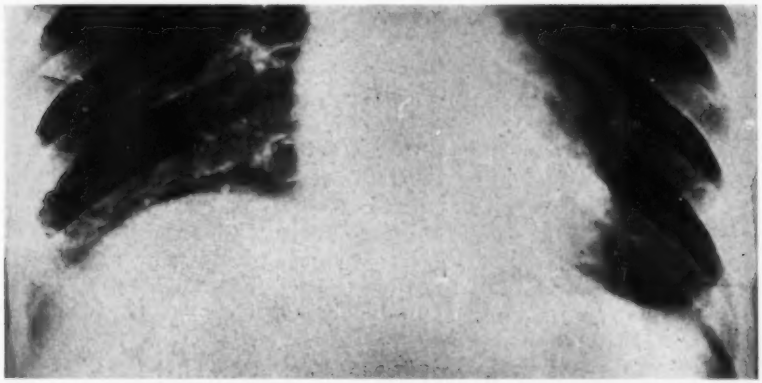

Fig. 1.

Fig. 2.

Fig. 1. Case 1. Oct. 13, 1949. Initial bilateral changes in costo-phrenic angles. Small pleural exudate. Finely mottled and streaky subpleural consolidation.

Fig. 2. Same case. 2 months later. Increased pleural exudate. Increased finely mottled and streaky consolidation at the lung-bases, more pronounced peripherally.

ADAMSON reported in 1947 six cases. In one of these, a bilateral exudate as well as a minor change of an atelectatic nature basally sited in the right lung was found. Another case had recurring bronchopneumonia while in a third case abundant parenchymal changes situated at the base of the right lung and accompanied by a rise in temperature was noted. Sections showed small pulmonary carnifications. There was no evidence of tuberculosis although there were signs of active phthisis in the other three cases.

KLEMPERER, POLLACK and BAEHR have 35 cases of disseminated lupus erythematosus in their *autopsy material* (1941), from which they give 20 abstracts. Three cases had pleuritic changes, three further cases showed parenchymal changes only and 14 cases presented both parenchymal and pleuritic changes. The pleuritis is reported in the various

Fig. 3. Case 1. 5 months later. Detail view of left lung. Partial regression.

cases as »acute fibrinous», »focal fibrinous», »acute fibrinous with effusion», »acute fibrinopurulent», »fibrous», »chronic fibrous», »chronic adhesive» or merely as »pleural effusion». Changes in the lung parenchyma are denoted as »pneumonia», »bronchopneumonia», »atelectasis», »focal atelectasis», and »infarction». In 11 cases these were localized to one or both lower lobes. According to these writers, pleurisy is thus very common and is often associated with pneumonia in an acute or chronic form.

TEILUM (1946) found a number of morphologically characteristic focal changes, most evident in the lung tissue just beneath the pleural surface. COSTELLO (1949) also found pleural effusion and numerous miliary lesions throughout the lungs at postmortem examination in a case of acute disseminated lupus erythematosus.

During the past five years, 15 cases of disseminated lupus erythematosus have been treated at the Military Hospital in Boden. A clinical report of these has been published in Acta Medica Scandinavica by BILLE (1951).

In four cases no roentgenologic changes were found. In one case there were old pleural changes with calcifications. In another, partial obliteration of the costo-phrenic angles on both sides, possibly due to small residues from old pleurisy, was noted. The changes in these two cases may probably be considered as secondary findings and not associated with the current disease. In another case there was calcification in the parenchyma of the middle lobe and in the right hilus. In addition, there were pleural changes on the same side in the form of thickening of the interlobar septum and obliteration of the costo-phrenic angle as well as peripheral consolidation, almost atelectatic, in the lower part of the middle lobe. It is probable, that the changes were also residues of an old tuberculous affection and unassociated with lupus erythematosus. In the remainder of the cases (8 of 15) pleural or parenchymal changes or combinations of these were observed and appeared to be caused by disseminated lupus erythematosus. Effusion in the pleura only occurred in two cases; one had small bilateral effusions, the other a pleurisy on the right side with parenchymal changes suggestive of tuberculosis, but

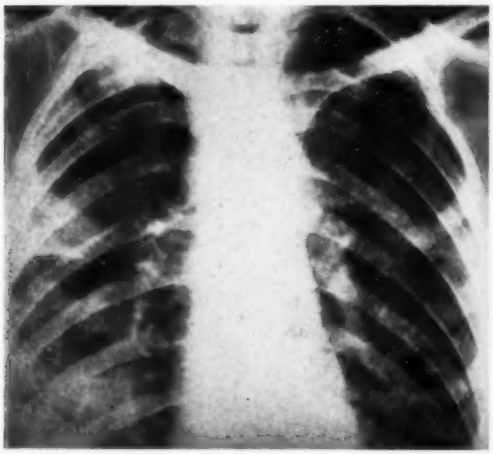

Fig. 4 a.

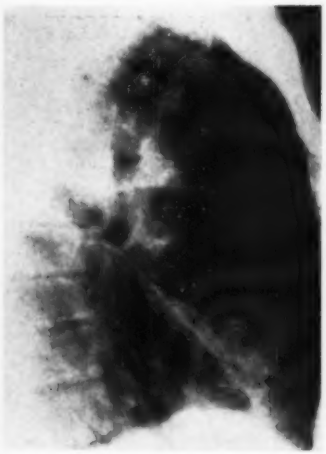

Fig 4 b.

Fig. 4 c.

Fig. 4 d.

Fig. 4. Case 1. 10 months later. Advanced stage. Disseminated changes in both lungs. Affection of lymphoglandulae, pleurae and pulmonary parenchyma.
a) Frontal view. b) Lateral view. c) Right lung. d) Left lung.

as no signs of active pulmonary tuberculosis could be found clinically, the pleurisy was presumably associated with lupus erythematosus.

In one case no changes were found during repeated roentgen examinations in the active phase of the disease but at a follow-up examination

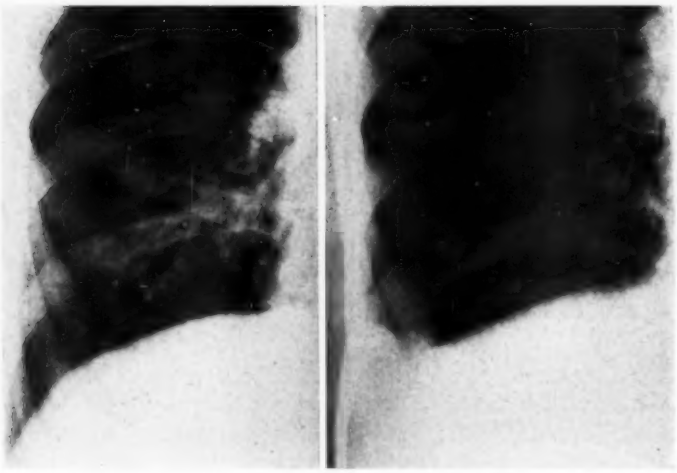

Fig. 5. Case 2. May 18, 1949. Slightly streaky infiltrate in right costo-phrenic angle.

Fig. 6. Same case. 5 months later. Small consolidation in costo-phrenic angle and thickened pleura (1 mm), costally.

several years later, a mottled and streaky consolidation was noted in the peripheral part of the right third intercostal space; the appearances remained unchanged during a four-month period of observation. Whether this lung change should actually be attributed to lupus erythematosus is somewhat uncertain.

The remaining five cases showed changes of a fundamentally similar character and are reported in detail.

Case Reports

1) S. V. D. ♂ aged 46.

During the course of disseminated lupus erythematosus bilateral lung changes occured and consisted of small quantities of fluid on both sides, particularly on the right, together with finely mottled and somewhat streaky subpleural consolidation, especially in the apical and basal parts of the lungs (fig. 1). There was a moderate glandular enlargement in the left tracheo-bronchial angle. Two months later (fig. 2) the changes had obviously progressed. However, after a further period of about three months the changes had partially resolved, although they remained in the peripheral parts of the lungs (fig. 3). This regression was of short duration, however, and after a further period of five months (fig. 4 a—d) the fluid had increased, especially on the right side. Further changes in the parenchyma consisted of disseminated, small, well-defined mottling with an interwoven streaky infiltrate. The pleural change on the left side appeared to consist largely of a thickening of the pleura without any obvious free exudate.

Fig. 7. Case 2. One year later. The changes have decreased.

Fig. 8. Case 3. Oct. 4, 1945. Thickened pleura in left costo-phrenic angle. Finely mottled and streaky subpleural infiltrate.

Fig. 9 a.

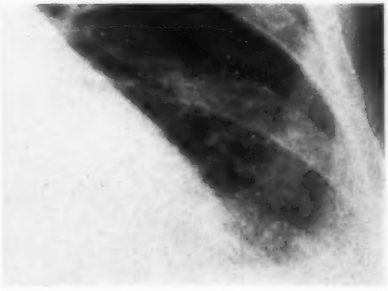

Fig. 9 b.

Fig. 9. Case 4. Bilateral changes in costo-phrenic angles. Some pleural thickening with subpleural streaking. a) Right base. b) Left base.

2) L. D. ♀ aged 34.

The patient fell ill in 1942. Roentgen examinations of the lungs in 1944 and 1948 demonstrated no pathologic changes. During 1949, however, signs appeared both in the form of pleural thickening and of fine subpleural basal streaks on the right side. The parenchymal changes were best seen at an earlier examination during the year (fig. 5) but became less obvious as the pleural changes grew more pronounced (fig. 6). After a year a slight decrease of the changes had taken place (fig. 7).

3) G. L. N. ♀ aged 21.

Suffering from disseminated lupus erythematosus the patient had a febrile attack with pleural crepitations lasting several days. Roentgen examination revealed a small

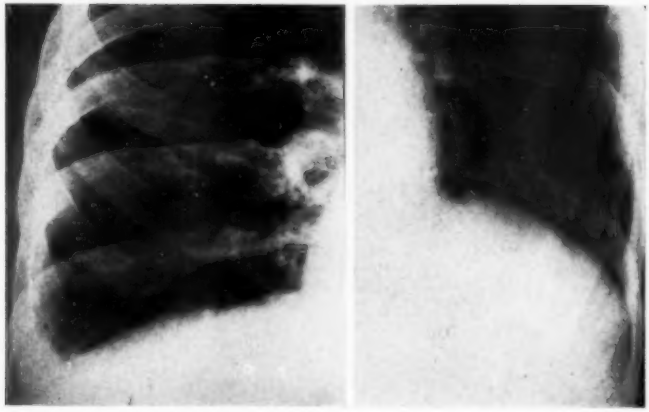

Fig. 10 a. Fig. 10 b.

Fig. 10 a—b. Case 5. Small pleural exudate. Finely mottled and streaky subpleural infiltrate.

Fig. 10 c. Pleural exudate costally in film taken in right lateral position with horizontally projected beam.

effusion in the left pleural cavity with streaky and fine mottling subpleurally at the base (Fig. 8). Aspiration produced a clear fluid containing only mononuclear cells (2,300 per mm³). A guinea pig test and Löwenstein culture were negative. The roentgenological changes gradually disappeared and two years later the lungs had completely normal roentgenological appearance.

4) J. V. N. ♀ aged 52.

The roentgenological changes in this case were fundamentally of the same appearances as the foregoing. Thus, there was pleural thickening and a moderate degree of streaking in the parenchyma below the pleura (figs. 9 a—b).

5) E. M. E. ♀ aged 46.

This case showed bilateral pleural changes with subpleural mottling and streaky parenchymal changes of the same appearance as in the other cases (figs. 10 a—c). The extent of the signs varied relatively rapidly at the various examinations.

Discussion

These five cases show appearances which although in themselves are not characteristic exhibit certain similarities. They all have pleural changes; the effusions are generally relatively small, but on the other hand more or less irregular pleural thickening is encountered. The pleural changes vary in extent within relatively short periods. In addition, there are parenchymal changes of a somewhat similar appearance and situation. These mostly lie subpleurally and are less marked in the central parts of the lung, a fact which may be convincingly demonstrated by the use of different oblique projections. In one of the cases this sign was more apparent when the changes were less pronounced (case 1); at the stage when the changes are most nearly disseminated (fig. 4) a predominatingly subpleural situation is not the rule. These roentgenological observations agree with TEILUM's morphological findings, *i. e.* the changes are most pronounced in the lung tissues just beneath the pleural surface. In the writer's opinion, a combination of pleural and parenchymal changes of the appearance found in these cases ought to lead to a correct diagnosis even if the changes in themselves may not be characteristic. A careful analysis of the lung changes occurring in disseminated lupus erythematosus should probably enable one to make a correct roentgenological diagnosis to a greater extent than is now considered possible.

SUMMARY

Lung conditions in 15 cases of disseminated lupus erythematosus are reported. There were roentgenologic changes in the lungs and pleurae in five of these cases. The pleural involvement was of a special nature and accompanied by subpleural infiltration in the lung parenchyma.

ZUSAMMENFASSUNG

Es wird über den Lungenstatus in 15 Fällen von Lupus erythematosus berichtet. In 5 Fällen fand man röntgenologische Veränderungen im Lungenparenchym und in den Pleurasäcken. Die pleurale Beteiligung war besondersartig und von subpleuraler Infiltration des Lungenparenchyms begleitet.

RÉSUMÉ

Note sur l'aspect pulmonaire chez 15 malades atteints de lupus érythémateux. Dans 5 de ces cas il y avait des altérations radiologiques au niveau des poumons et de la plèvre. La lésion pleurale avait un caractère spécial et était accompagnée d'une infiltration sous-pleurale du parenchyme pulmonaire.

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THE ROENTGENOLOGICAL PICTURE IN CHRONIC, NON-SPECIFIC FIBROSIS OF THE MIDDLE LOBE, WITH SPECIAL REGARD TO THE VALUE OF PLANIGRAPHY

by

Haakon Ødegaard

In recent years increased attention has been paid to non-specific, localized chronic atelectasis and fibrosis in the middle lobe of the lung. This is due mainly to the problems presented in the differential diagnosis of these conditions, especially by bronchial tumours.

It was GRAHAM, BURFORD and MAYER (2) who in 1948 introduced the conception of a middle lobe syndrome, whereby they designated the chronic, non-specific middle lobe atelectasis as a separate form of disease. They believed that in the 12 cases which they reported the pathological changes in the form of bronchostenosis and obstructive pneumonitis had been occasioned by enlarged lymph nodes which had led to a compression of the middle lobe bronchus. PAULSON and SHAW (6) have later reported 32 cases with chronic atelectasis and fibrosis in the middle lobe, and they mention that the symptoms most frequently noted are cough, pain (which often seems to be a characteristic anterior pain), dyspnoea, hemoptysis and wheezing. These authors state that in several cases the middle lobe bronchus is found to be markedly constricted, and that several mechanical factors may contribute to the development of chronic atelectasis and chronic pneumonitis. For instance, the fact that the middle lobe bronchus arises at almost a right angle from the stem bronchus may lead to poor drainage, the small segmental bronchi may easily be blocked up by inflammation or edema, while enlargement of the lymph nodes, which almost entirely surround the middle lobe bronchus, may

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cause pressure on that bronchus. Other authors (1, 8) have also pointed out that the middle lobe bronchus is particularly susceptible to pressure.

A brief account will be given here of 20 patients with chronic middle lobe fibrosis of non-specific nature, whom we have examined in the Department of Roentgenology of the University Hospital. They comprise 11 females and 9 males, aged from 24 to 70 years, 11 being more than 50 years old. Six of these patients had previously suffered from pneumonia, in two cases recurrently. One had had pleuritis, and one had had tuberculous lung disease several years previously.

In five patients the disease must be said to have been discovered accidentally, in two by mass photofluorography, and in three patients by other routine examinations of the chest. The remaining fifteen patients presented themselves for examination on account of recurrent colds, bronchitic symptoms or persistent cough, sometimes with expectorate. Hemoptysis occurred in a total of 10 cases. From the case records a further characteristic feature appeared to be that most of the patients were in good general condition, and that very often nothing pathological was noted on ordinary physical examination of the chest. No signs of tumour or specific inflammation were found in any of the cases.

Planigraphy was employed in eighteen cases, and in six of these cases, where bronchoscopy revealed distinct constriction of the middle lobe bronchus, manifestation of this was also found by planigraphy. Moreover, in seven cases a calcified lymph node was seen on the planigrams, close to the bronchus of the middle lobe. In eleven cases signs of bronchiectases were revealed by planigraphy, and in ten cases, in which also bronchography was performed, this finding was confirmed. Bronchiectases were discovered in a further two cases by bronchographic examination. Moderate bronchiectatic changes were noted also in the anterior segment of the upper lobe in one patient and in the lower lobe in two patients. In one case an abscess was discovered in the middle lobe.

A more detailed account will be given of five cases, especially in order to show the importance of planigraphic examinations. It is the lateral planigrams that are of particular value in case of affection of the middle lobe.

Case 1. O. S., male aged 61, who was called up for roentgen examination after mass chest radiography. About 30 years previously he had had a severe attack of »Spanish flu». Otherwise he had been well, except for a little shortness of breath in recent years. Had been working for 33 years on tunnels.

Roentgen examination (figs. 1 a—c) revealed, besides moderate silicotic changes in the lungs, marked fibrosis limited to the middle lobe. On planigraphic examination a considerable constriction of the middle lobe bronchus was found immediately before its bifurcation. This finding was verified by bronchography as well as by bronchoscopy. Biopsy disclosed hyperplastic epithelium. Operation was not considered to be indicated.

Fig. 1 a.

Fig. 1 b.

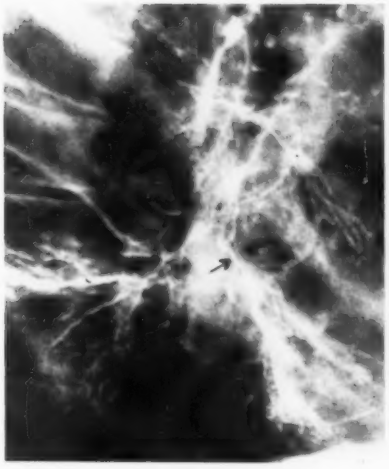

Fig. 1 c.

Fig. 1. Case 1.

a) Marked fibrosis of middle lobe.
b) Lateral planigram showing the constricted middle lobe bronchus surrounded by enlarged lymph nodes.
c) Bronchography. Bronchial stenosis (arrows). Bronchiectases of middle and lower lobes.

Case 2. P. L., male aged 68. For 30 years he had had repeated attacks of moderate hemoptysis at intervals of several years. Otherwise he had been quite well. Roentgen examination (figs. 2 a—d) demonstrated middle lobe fibrosis with shrinkage, distinctly visible on the lateral planigrams, which also showed a patent middle lobe bronchus as well as peripheral cylindrical bronchiectases. This finding was verified by bronchography. Bronchoscopy revealed no stenosis or secretion, but numerous dilated vessels with a tendency to bleeding in the bronchial tree on the right as well as the left side were noted.

Fig. 2 a.

Fig. 2 b.

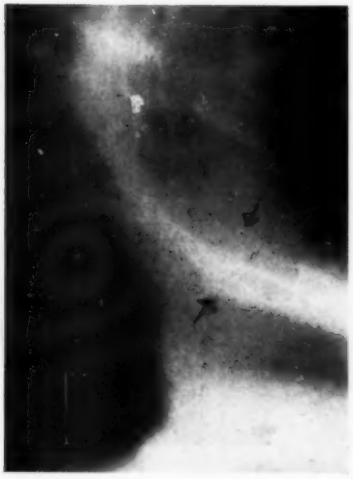

Fig. 2 c.

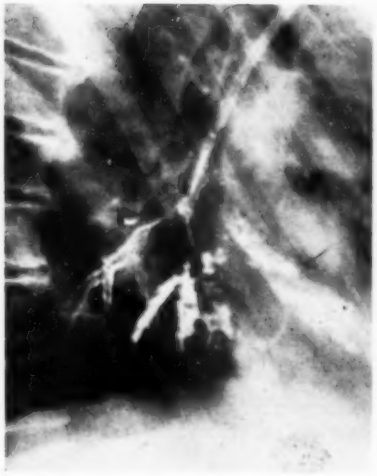

Fig. 2 d.

Fig. 2. Case 2.

a) Preliminary film, frontal view.
b) Lateral planigram. Middle lobe bronchus of normal calibre.
c) Planigram. Shrunken middle lobe with fibrosis and bronchiectases.
d) Bronchography. Bronchiectases of the middle lobe and of the cardiac segment.

Fig. 3 a.

Fig. 3 b.

Fig. 3 c.

Fig. 3 d.

Fig. 3 e.

Fig. 3. Case 3.

a) Preliminary film, frontal view.
b) Planigraphy through lateral part of middle lobe showing the atelectatic lateral segment.
c—d) Middle lobe bronchus patent. Inner contour of undulating appearance.
e) Bronchography of the middle lobe. No contrast filling of the atelectatic lateral segment, moderate bronchiectases of the medial segment.

Case 3. S. J., male aged 51. In the course of one year he had had several small hemoptyses together with a little cough and expectorate. Roentgen examination (figs. 3 a—e) showed atelectasis in the lateral segment of the middle lobe. On planigraphy the ostium of the middle lobe was observed to be patent. The internal contour, however, had a slightly undulant appearance, noted also on the bronchograms, and which may well tally with the fact that the mucous membrane was found by bronchoscopy to be injected and swollen. Bronchography disclosed no contrast filling of the atelectatic lateral segment, while in the medial segment, containing air, small cylindrical bronchiectases were found. Biopsy revealed signs of a moderate degree of chronic inflammation in the bronchial mucous membrane.

Case 4. R. W., female aged 58. For one year she had had cough and expectorate after a severe cold. Roentgen examination (figs. 4 a—d) revealed signs of fibrosis in the middle lobe as well as in the anterior segment of the upper lobe. A planigram of the middle lobe bronchus showed it to have an oblique course and to be of uniformly narrow calibre, verified by bronchoscopy. Lateral planigrams also disclosed cylindrical bronchiectases in the shrunken middle lobe, which finding was verified by bronchography as well as at the subsequent operation.

Case 5. Å. E., female aged 38. Alleged tuberculous lung disease in childhood. Two years ago she had pneumonia. Of recent years she has frequently had a cough with expectorate, sometimes blood-stained. Roentgen examination (figs. 5 a—d) showed calcifications in both lungs, while the bronchiectases in the greatly shrunken, fibrotic middle lobe are clearly visible on frontal as well as lateral planigrams. The middle lobe bronchus was found to be patent. This finding was verified by bronchography and at the subsequent operation in the Department of Surgery, Section A. Pathological-anatomical examination demonstrated chronic inflammation, fibrosis and bronchiectasis.

With regard to differential diagnosis it has been emphasized (1) that in all cases of middle lobe affection the possibility of a tuberculous process must be taken into consideration. Further, the differential diagnosis from bronchial tumour is very important. Planigraphy may furnish some evidence for the decision of the question, as, in case of tumour, the bronchial lumen will often appear to be occluded straight across. Fig. 6 shows a lateral planigram of a man, aged 49, who had had atelectasis of the middle lobe for six years with intermittent cough and expectorate. The presence of bronchial stenosis was verified by bronchography (fig. 7), and bronchoscopy revealed an occluding bronchial adenoma. Moreover, in case of bronchial cancer planigraphic examination will frequently demonstrate signs of expansive tumour infiltration in the hilum, in addition to bronchial stenosis (fig. 8). In this latter case bronchoscopy in a 70-year-old man demonstrated an occluding carcinoma immediately peripherally to the ostium of the middle lobe. On planigrams this expansive process may be seen sometimes to dislodge and deform the adjoining bronchi (fig. 9; a carcinoma constricting the ostium of the middle lobe).

Fig. 4 a.

Fig. 4 b.

Fig. 4 c.

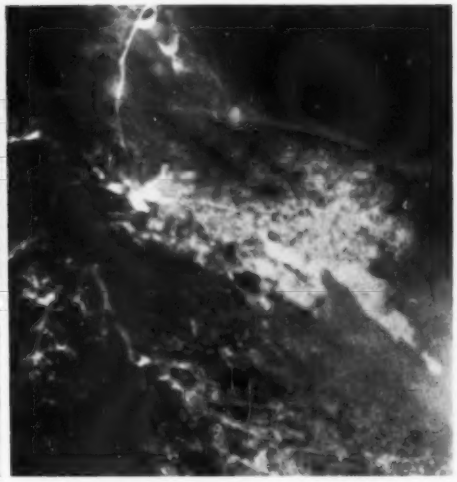

Fig. 4 d.

Fig. 4. Case 4.

a) Slight fibrosis of middle lobe and anterior segment of upper lobe.
b) Lateral planigraphy. Note the oblique course of the patent, but slightly narrowed, middle lobe bronchus.
c) Planigraphy. Fibrosis and bronchiectases of the middle lobe.
d) Bronchography.

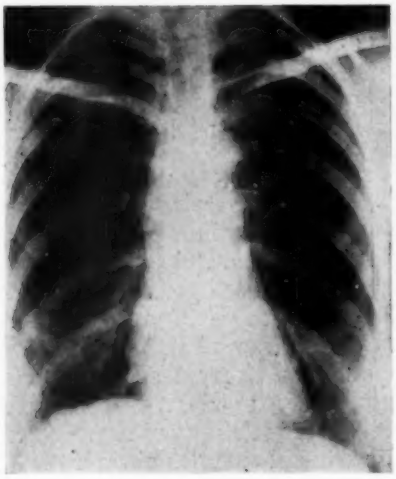

Fig. 5 a.

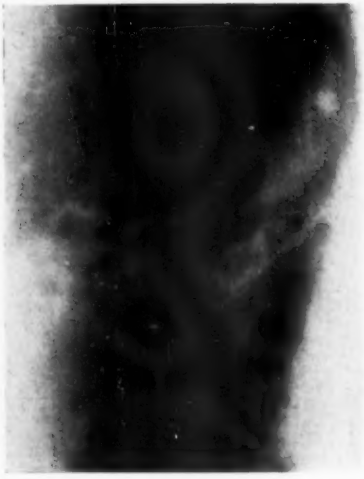

Fig. 5 b.

Fig. 5 c.

Fig. 5 d.

Fig. 5. Case 5.

a) Preliminary film, frontal view.
b) Frontal planigraphy. Fibrosis and bronchiectases.
c—d) Lateral planigraphy. Atelectatic lobe with bronchiectases. The middle lobe bronchus is patent.

Fig. 6. Case 5. Blocked middle lobe bronchus with complete atelectasis of the middle lobe.

Fig. 7. Case 5. Bronchography. Bronchial occlusion. Bronchoscopy revealed an occluding bronchial adenoma.

Fig. 8. Case 5. Planigraphy of occluding bronchial cancer in the middle lobe. Large tumour mass in the hilum. Explorative thoracotomy revealed an inoperable cancer.

Fig. 9. Case 5. Planigraphy of middle lobe atelectasis: cancer occluding the ostium of the middle lobe bronchus (upper arrow). Note the dislocation and slight constriction of the lower lobe bronchus due to the tumour mass (lower arrow).

Comments and Conclusions

The same symptoms may appear and the identical peripheral changes occur in the middle lobe both with and without bronchial stenosis. It seems hardly justifiable, therefore, to include in so-called middle lobe syndromes only those cases which present stenosis of the middle lobe bronchus (5). It is already known that non-specific, inflammatory changes in the bronchial wall may give rise to stenosis (3, 7), which may be of a transitory nature (4), and that the bronchial lumen may be completely restored after having been compressed by enlarged lymph nodes (1). Thus, if an obstructive pneumonitis develops, the secondary changes produced in the form of shrinkage, fibrosis and/or bronchiectases, may persist even though the stenosis subsides or disappears entirely.

Chronic non-specific atelectasis and fibrosis of the middle lobe constitute a condition which roentgenologists not infrequently have to take into consideration. There is good reason to emphasize the usefulness of planigraphy in the evaluation of cases. This method helps us to determine the extent of fibrosis or atelectasis, and to discover bronchiectases and possibly existing abscesses, while by lateral planigraphy we are able in most cases to obtain a satisfactory picture of the course and calibre of the middle lobe bronchus. We believe that this method of examination is a valuable contribution to the close collaboration necessary between radiologists, bronchoscopists, pathologists, bacteriologists and clinicians to ensure the best possible ultimate judgment of each individual case.

SUMMARY

Eighteen cases of chronic, non-specific middle lobe fibrosis were examined by planigraphy. By this method, especially lateral planigraphy, a satisfactory view of the course and calibre of the middle lobe bronchus is generally obtained as well as of the extent of any secondary changes in the parenchyma. In most cases no constriction of the middle lobe bronchus was found, and there seems to be no reason for confining the term »middle lobe syndrome» only to those cases, in which such constriction is demonstrated at the time of examination. The differential diagnosis of tumour is discussed.

ZUSAMMENFASSUNG

18 Fälle nicht spezifischer, chronischer Mittellappenfibrose wurden planigraphisch untersucht. Mit dieser Methode, insbesondere der lateralen Planigraphie, erhält man gewöhnlich sowohl ein gutes Bild über den Verlauf und das Kaliber des Mittellappenbronchus als auch über die Ausdehnung sekundärer Veränderungen des Lungenparenchymes. In den meisten Fällen fand man keine Verengerung des Mittellappenbronchus; es scheint kein Grund vorzuliegen, den Ausdruck Mittellappensyndrom nur für diejenigen Fälle zu benutzen, bei denen eine derartige Verengerung bei der Untersuchung demonstrierbar ist. Die Differentialdiagnose gegenüber Tumor wird besprochen.

RÉSUMÉ

Dix-huit cas de fibrose chronique, non spécifique, du lobe intermédiaire ont été examinés par planigraphie. Par cette méthode, spécialement par la planigraphie latérale, on peut généralement obtenir une vue satisfaisante du parcours et du calibre de la bronche du lobe intermédiaire ainsi que de l'étendue des altérations secondaires éventuelles du parenchyme. Dans la majorité des cas il n'y avait aucun rétrécissement de la bronche du lobe intermédiaire. Il semble donc qu'il n'y ait aucune raison de réserver le terme »syndrome du lobe intermédiaire» uniquement pour les cas dans lesquels un tel rétrécissement est révélé au cours de l'examen. La différence entre ce diagnostic et celui des tumeurs est discutée.

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FREQUENCY OR WAVELENGTH IN ROENTGEN ENERGY DISTRIBUTION DIAGRAMS

by

Bo Lindell

The energy distribution of the continuous roentgen spectrum obtained at different potentials from a massive thick target, may be represented by curves as shown in Fig. 1.

We shall not here discuss the theoretical analysis of the distribution, but point out that this way of showing the energy might be misunderstood by anyone not accustomed to the subject.

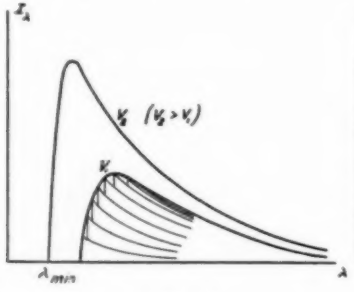

Fig. 1.

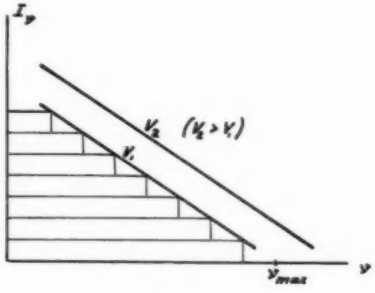

Fig. 2.

It is well known that the energy distribution can be given as a very simple function of the frequency. WEBSTER (6) has pointed out that the rays of maximum frequency can be generated only in a thin surface layer of the target as no electrons reach a deeper layer maintaining their initial energy. Thus the spectrum from a thick target can be considered to consist of contributions from thin layers of different depths as indicated in Fig. 1.

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NICHOLAS (5) has shown experimentally that spectra from thin targets have a distribution that can be described by the equation,

$$I_\nu \, d\nu = \text{const.} \; d\nu \quad (\nu < \nu_0)$$

thus verifying a theoretical calculation first proposed by KRAMERS (3). By applying the THOMSON-WHIDDINGTON law (7) to the loss of energy of the electrons in the targets, KRAMERS has calculated the energy radiated per electron impact in a thick target between frequencies ν and $\nu + d\nu$ as

$$I_\nu \, d\nu = C \cdot Z \; (\nu_0 - \nu) \, d\nu$$

KULENKAMPFF (4) has given an empirical formula,

$$I_\nu = AZ \; (\nu_0 - \nu) + BZ^2$$

where the second term may often be neglected and the first one is identical with Kramers' expression.

These equations show a linear relation between the energy per frequency interval and the frequency (fig. 2).

The slope of the curves is proportional to the atomic number Z of the target material and independent of the tube voltage, *i. e.* the initial velocity of the electrons.

Other investigations and theories, some of them reported in COMPTON and ALLISON's monograph (1) differ little from the facts given above. The validity of the linear relation at therapy energies is verified in recent experiments by S. JOHANSSON (2).

Now, if we compare these curves with the curves in Fig. 1, we find no correspondence to the maximum of the I_λ (λ)-functions. If we want to transform the I_λ (λ)-curves to the I_ν (ν)-diagram we must use the relation

$$I_\nu = \frac{c}{\nu^2} \cdot I_\lambda$$

because $I_\nu / I_\lambda = -d\lambda / d\nu = c / \nu^2$ since $\lambda = c/\nu$ and $|I_\nu \, d\nu| = |I_\lambda \, d\lambda|$ (as the area under the curves represents the same amount of energy).

After this transformation we have obtained monotonous curves. The I_λ (λ)-curves have a maximum at $\lambda = \frac{3}{2} \cdot \lambda_{min}$. The corresponding point in the I_ν (ν)-diagram is $\nu = \frac{2}{3} \cdot \nu_{max}$ where nothing characteristic is to be seen.

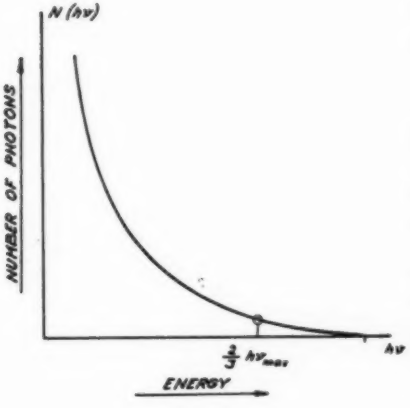

Fig. 3.

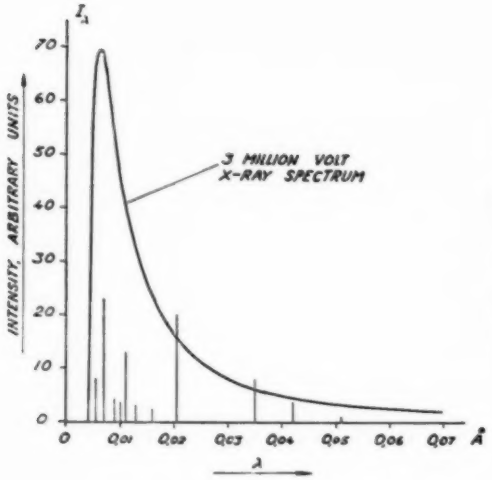

Fig. 4.

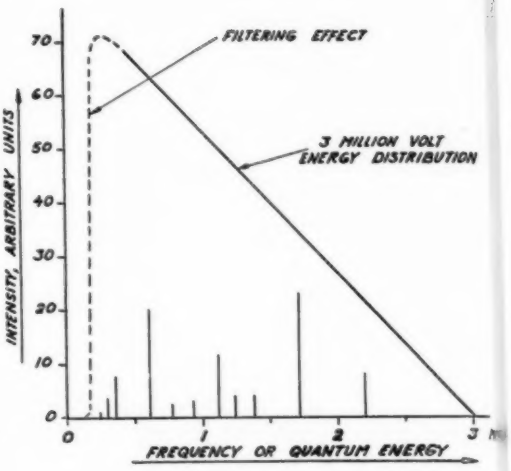

Fig. 5.

These are all things physicists know though their real importance is not seldom overlooked by many of them. But a radiologist who has no reason to brood on physical subtilities may draw the wrong conclusion. He may say: »$3/2 \cdot \lambda_{min}$ is the most frequent wave-length» or »the energy has a maximum at $3/2 \cdot \lambda_{min}$». But he will be completely wrong. The function that has a maximum at $3/2 \cdot \lambda_{min}$ is *the energy per wavelength-interval*, a rather abstract mathematical concept.

If we could count the photons generated in the target and measure their energies, we should be able to draw a third kind of distribution curve, viz. the statistical distribution of photons on different energy amounts $h\nu$. This would be a function of practical interest. We can, however, derive it from the I_ν (ν)-function, because in an interval $d\nu$ there is the energy $I_\nu d\nu$ and the number of photons $I_\nu d\nu/h\nu$, *i. e.* we must divide I_ν by ν to get the number of photons per energy interval, $N(h\nu)$. Then we obtain curves showing that the lower the energy the larger is the number of photons (fig. 3).

From these curves we see that the far greatest number of photons have a very small energy, the point corresponding to $3/2 \cdot \lambda_{min}$ being of little importance.

We must, however, remember that this way of representing the distribution is justified only when we are interested in just the *number* of photons. The most frequent, low-energetic photons represent little relative energy, and if we want to know the *energy* distribution it is

convenient to use the I_ν (ν)-curves as the energy is proportional to ν. But in neither case should we use the I_λ (λ)-diagram, as it does not show the distribution of energy (or photons) but the distribution of the pure mathematical quantity: energy per wavelength-interval.

Very often one can see curves of the type I_λ (λ), *e. g.* fig. 4, published to illustrate the efficiency of super-voltage compared with the γ-radiation from radium.

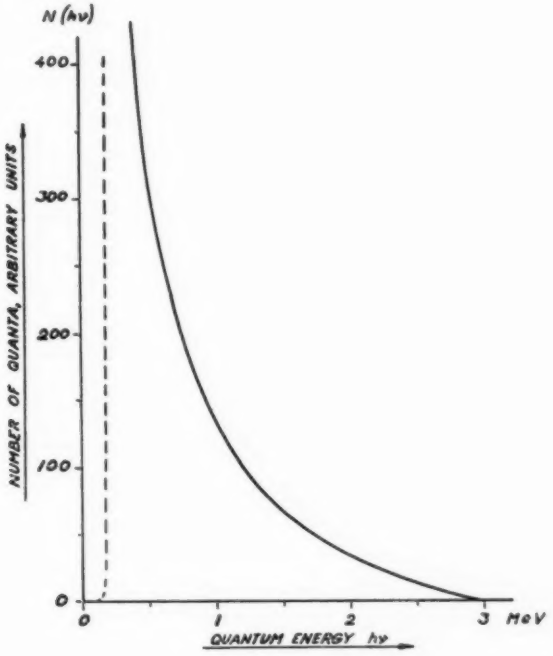

Fig. 6.

This is a false representation. The γ-intensities are not real intensities per interval but *total* energies and thus their relative ratio will be independent of whether the diagram is a distribution over wave-lengths or frequencies. Furthermore the maxima of the curves give the misleading impression that most of the radiated energy is transferred by high-energetic quanta. On the contrary, the principal difference between γ-rays and supervoltage roentgen rays is that the γ-rays consist of exclusively high-energetic quanta while the high energy roentgen rays are always associated with a very large amount of photons of low energy, as can be seen from fig. 5 and 6 showing the energy per frequency in-

terval and the number of photons distributed on different amounts of energy.

Considering the accessibility and clearness of the $I_\nu(\nu)$-diagram in general and especially for calculations of filtering and depth effects, it is surprising that so many people use the $I_\lambda(\lambda)$-diagrams, which are nothing but rough results from spectral investigations.

SUMMARY

The author draws attention to the fact that the common way to present roentgen energy distribution gives the misleading impression that there is an energy maximum at about 3/2 the minimum wavelength. He points out that most of the energy is transferred by quanta of much greater wavelength, *i. e.* soft radiation, and that high-voltage roentgen rays are not as easily compared with *c. g.* γ-rays from radium as is often assumed.

ZUSAMMENFASSUNG

Der Autor macht darauf aufmerksam, dass die übliche Methode, die Verteilung der Roentgenenergie darzustellen, den falschen Eindruck ergibt, dass das Maximum der Energie bei ungefähr 3/2 der Minimumwellenlänge läge. Er weist darauf hin, dass der Hauptteil der Energie aus Quanta viel grösserer Wellenlänge, also weicherer Strahlung, besteht und dass Millionenvoltroentgenstrahlen nicht so leicht mit z. B. γ-Strahlen von Radium zu vergleichen sind wie so oft angenommen wird.

RÉSUMÉ

L'auteur attire l'attention sur le fait que la manière habituelle de présenter la distribution de l'énergie de radiation donne l'impression erronée qu'il y a un maximum d'énergie correspondant a 3/2 de la longueur d'onde minimum. Il fait ressortir que la plus grande part de l'énergie est transférée par des quanta de longueur d'onde bien plus grande, par des rayons moux, et que les rayons roentgen à haut voltage ne sont pas aussi aisément comparables aux rayons γ du radium comme on le pense souvent.

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PHILIPS RESEARCH LABORATORIES N. V. PHILIPS GLOEILAMPENFABRIEKEN,
EINDHOVEN—THE NETHERLANDS

FREE-AIR AND THIMBLE IONIZATION CHAMBERS FOR GRENZ-RAY DOSIMETRY

by

W. J. Oosterkamp and *J. Proper*

1. Introduction

The application of soft roentgen rays has received a new impetus by the introduction of tubes that are much more suitable for this purpose than those of the old type of construction having very thin bubble windows or windows of Lindeman glass. The tubes referred to are those with a beryllium window and, more recently, those having a very thin mica window joined to the stainless steel body of the tube with some form of enamel.

The measurement of the output of these tubes has given rise to some complications, not only owing to the fact that the radiation is very soft and heterogeneous, but also on account of the high dose rates; these are obtained as a consequence of the low inherent filtration, coupled with the fact that the tubes are often used at very short focus distances. Computing the dose at small focus distances by means of the inverse square law from measurements taken at larger focus distances is not permissible owing to the considerable absorption of the radiation in air (2).

2. Free-air Chamber

Our free-air chamber is based on a design of TAYLOR and STONEBURNER, published in 1932 (7).[1]

The chamber is of the guarded field type and is shown schematically in fig. 1.

Submitted for publication, August 10, 1951.

[1] Thanks are due to Dr. LAURISTON S. TAYLOR of the National Bureau of Standards in Washington for putting the drawings of his chamber at our disposal.

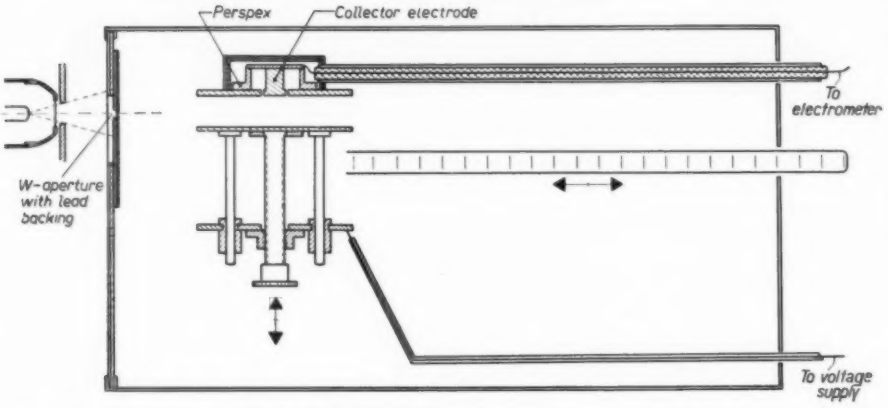

Fig. 1. Cross-section of the standard ionization chamber for Grenz-ray measurements (modified TAYLOR and STONEBURNER design).

We have made a few modifications to the design of TAYLOR and STONEBURNER in order to be able to measure considerably higher dose rates. Instead of the 8 mm aperture, we used only a 1 mm circular aperture for the highest dose rates and for smaller dose rates, one of 3 mm.[1] When small apertures are used, the total ionization and also the ionization density is decreased; the latter effect is due to the lateral spread of the secondary electrons beyond the geometrical shadow of the aperture. Thus the recombination of ions and electrons is prevented already at lower field strengths.

Using small apertures however complicates matters. If the size of the aperture is smaller than the focal spot, then the amount of radiation entering the ionization chamber is less than corresponding to the area of the aperture. In the case where the focal spot is smaller than the bore of the diaphragm, the angular aperture of the roentgen ray beam entering the ionization chamber is determined by the area and position of the end of the bore (assumed to be of a cylindrical shape), that is farthest from the focal spot (Plane R in fig. 2). However, if the focal spot is larger than this bore, the radiation coming from the periphery of the focal spot (between C and A) is not only limited by the end-face of the bore but also by the front-face (Plane F). The effective area is thus determined by the overlap of two circles, the centres of which are a short distance apart; their relative positions are different for each point of the focal spot. This effect, which is the more important

[1] The use of a 1 mm aperture is also described in a recent publication by TAYLOR (6).

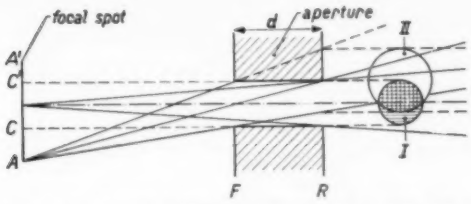

Fig. 2. Illustration of the reduced effective area of the aperture when the focal spot is larger than the bore of the aperture. The effective area of the aperture for the central part CC' of the aperture is equal to the entire circle I (shaded horizontally or horizontally *and* vertically). For a point A at the periphery of the focal spot, the effective area of the aperture is reduced to that part of circle I which is also covered by circle II (shaded horizontally and vertically).

the shorter the focus distance and the smaller the aperture, can be minimized by making the depth d of the aperture as small as possible. Our 1 mm aperture was made of tungsten 0.3 mm thick, backed by a 1 mm lead disc with a hole slightly larger than 1 mm. The 3 mm aperture is made of type metal 1.0 mm thick.

A second modification making the instrument more suitable for high dose rates is a shorter distance between the measuring electrodes. In our chamber the distance between the electrodes can be varied. The highest dose rates will occur if no filter is placed in the roentgen ray beam. This radiation is very soft and therefore the range of the secondary electrons is short. In these circumstances a comparatively small electrode distance — 15 mm — can be employed. For filtered radiation a larger electrode separation — 30 mm — is necessary, but owing to the lower dose rate, saturation is still maintained. Saturation current at a dose rate of 50,000 r/min. was obtained at 250 V between the electrodes with an electrode spacing of 15 mm and at 600 V with an electrode spacing of 30 mm.

Two methods are employed for measuring the ionization current. For general use the ionization current is led through a high-ohmic resistance; the voltage drop across this resistance is measured with a dynamic electrometer with three ranges of 100, 300 and 1,000 mV full scale deflection (8). By manual adjustment of a potentiometer, care is taken to keep the measuring electrode and the guard electrodes at exactly the same potential. If extreme accuracy is required, we use capacitive compensation of the ionization current by means of a Harms condenser (5).

When measurements with the aperture at 8 cm or more from the focal spot are made, the absorption in the air between the aperture and the centre of the measuring electrode (42 mm) can be determined

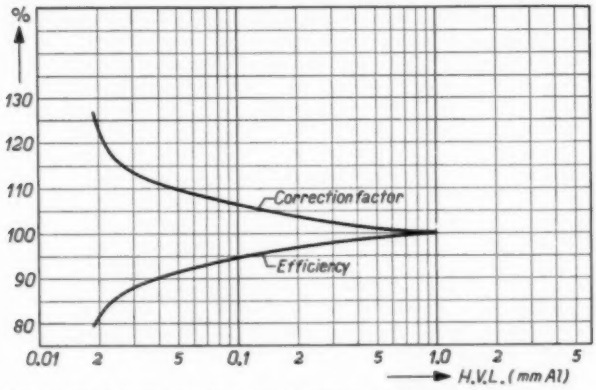

Fig. 3. The loss in efficiency due to air absorption between the aperture and the centre of the measuring electrode (42 mm) and the air absorption correction factor of the standard ionization chamber.

by placing the box with the aperture 42 mm nearer to the focal spot and shifting the electrode system over 42 mm within the box as indicated by TAYLOR (7). When measurements at a focus distance smaller than 8 cm have to be made this method cannot be used; the absorption correction is then determined in the following 42 mm. This introduces a small error due to the curvature of the logarithmic absorption curve. However, this curvature is not very large and, as the absorption never exceeds 28 %, this error will not materially affect the results. In fig. 3 the air absorption effect is shown as a function of the half value layer of the radiation. The softest radiation was excited at 10 kV peak, without additional filter. This radiation has a half value layer of 0.018 mm Al.

In fig. 4 dose measurements with different aluminium filters are given for a contact cavity therapy tube with a window of 25 μ mica + 0.7 mm beryllium (the total filter is equivalent to 40 μ Al). The measurements were carried out at a focus distance of 4 cm. The tube current was 2 mA ; a constant potential generator was used; the ripple was 3 kV.

3. Thimble Chambers

There are two complications when thimble chambers have to be used for Grenz rays: the absorption in the wall of the chamber (9) and the effective atomic number of the wall is much more critical than it is in the case of deep therapy.

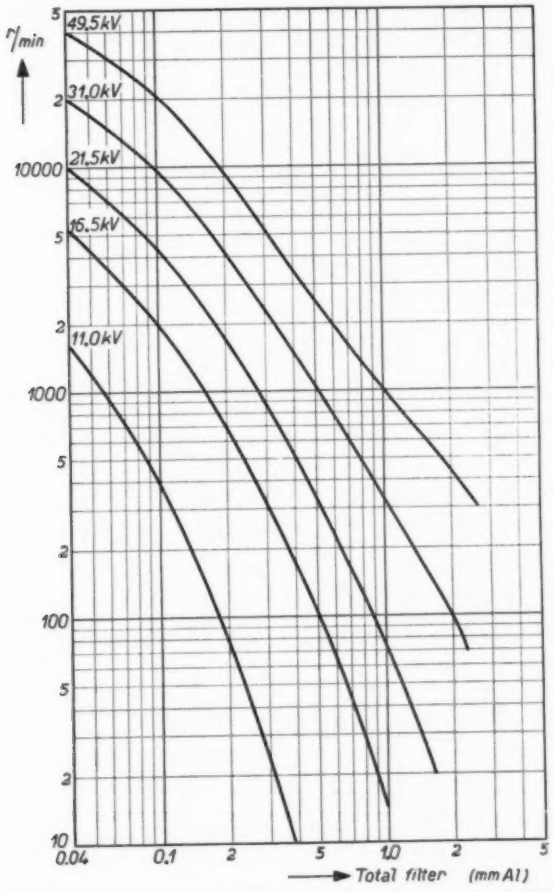

Fig. 4. Characteristic absorption curves in aluminium of a Contact Therapy tube with a window of 25 μ mica + 0.7 mm beryllium (total is equivalent to 40 μ Al) for different tube voltages. Constant potential, 2.0 mA; 40 mm focus distance.

For a better understanding of the latter point it is necessary to consider the mechanism of the ionization process in thimble chambers. A thimble chamber is a well-defined volume of air entirely surrounded by a wall. When such a chamber is placed in a beam of roentgen rays, secondary electrons will be released in the air volume and in the wall material. These secondary electrons move through the air or the wall material and cause the formation, along their tracks, of a large number of ion pairs.

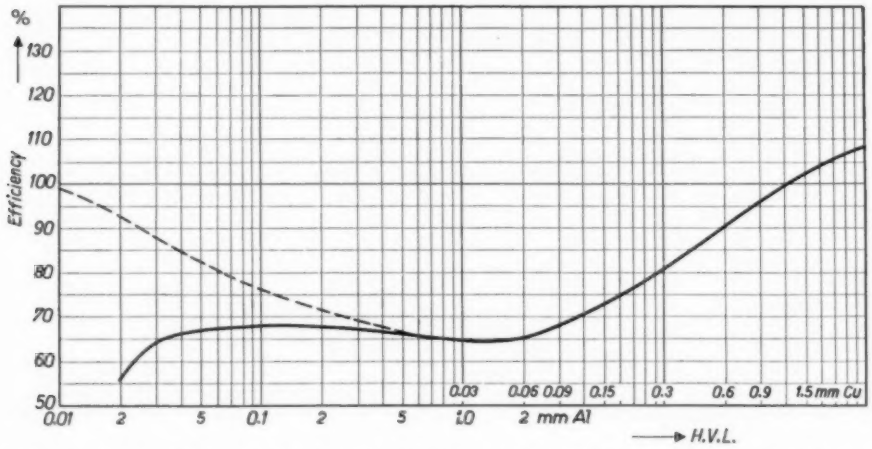

Fig. 5. The efficiency of a flat ionization chamber as a function of the hardness of the radiation. For soft radiation the hardness is expressed by the H. V. L. in Al, for harder radiation by the H. V. L. in Cu; polystyrene walls with aquadag electrodes, window thickness 0.45 mm; distance between the electrodes 0.65 mm. The dotted line is corrected for the attenuation of the beam in the wall. Transition from ionization predominantly by cavity photoelectrons to that predominantly by wall photoelectrons at 0.05 mm Al; transition from predominant photo effect to predominant Compton effect at 0.6 mm Cu H. V. L.

For *deep therapy radiation* the range of the secondary electrons is several centimetres and therefore considerably larger than the dimensions of the usual thimble chambers. Thus the secondary electrons that are released in the air volume, will lose only a small fraction of their energy in the air before they strike the walls, the remainder of their energy being dissipated in the wall and not contributing to the ionization in the air volume. On the other hand numerous secondary electrons released in the wall will traverse the air volume and cause ionization. Therefore in deep therapy the total ionization in the air cavity is mainly due to secondary electrons released by the roentgen rays in the wall.

For radiation with a half value layer of 1 mm Cu or more, as is used in deep therapy, the formation of secondary electrons is almost entirely due to the Compton effect. In materials with a relatively low atomic number the Compton effect is practically independent of the atomic number, since it depends almost entirely upon the number of electrons per gram of material; this is nearly constant for all materials. The only exception is hydrogen, where the number of electrons per gram is twice

as high as in other materials. Substances with the highest relative hydrogen content are the paraffines (C_nH_{2n+2}) and water, where the Compton effect per gram is about 10 % higher than that in substances not containing hydrogen, for instance dry air or graphite. From the foregoing it follows that, as long as the wall material does not contain too much hydrogen, all light materials are almost air equivalent for hard radiation, and therefore the composition of the wall material is not very critical.

Matters become more complicated for softer radiation in the case of *intermediate therapy*, the photo-electric absorption instead of the Compton effect becoming predominant for the release of secondary electrons. It has already been remarked that the Compton effect is only to a slight extent dependent upon the atomic composition of the material. Photo-absorption, however, is proportional to the third power of the atomic number, and therefore the atomic composition is very critical for air equivalence. The photo-absorption in graphite for instance is less than 50 % of the absorption in air. The Compton effect and the photo absorption have the same value in air for radiation of a H. V. L. of 0.6 mm Cu.

Going to still softer radiation, *superficial therapy* and *Grenz rays*, another aspect is important. The range of the secondary electrons will be smaller than the dimensions of the chamber. In the centre of the ionization chamber the ionization is now only caused by electrons released in the air cavity itself, and near the walls there is a sheath of air where the ionization is mainly caused by secondary electrons released in the walls. Therefore the softer the radiation, the less will be the effect of the composition of the wall material — at least, as long as the attenuation of the beam by the wall is disregarded.

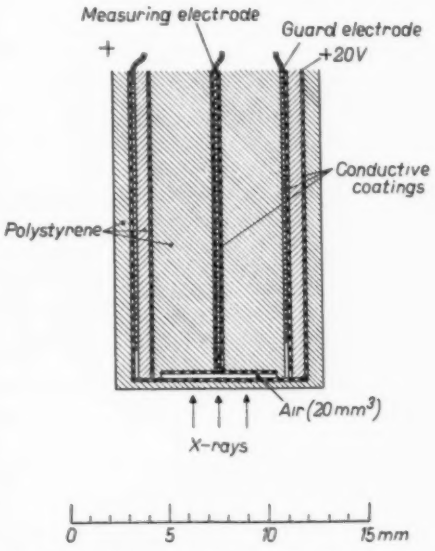

Fig. 6. Cross section of flat ionization chamber.[1]

[1] There is practically no potential difference between the measuring electrode and the guard electrode in our measuring circuit. Therefore any conductivity, eventually induced in the insulator by the radiation, cannot affect the results of the measurements.

The *efficiency* of a thimble chamber is to be defined as the ratio of the ionization actually produced in the chamber to the ionization brought about in the same volume of air in a standard chamber. Fig. 5 illustrates how the efficiency of a flat thimble chamber (fig. 6) with a wall material (polystyrene with a coating of graphite), having an effective atomic number lower than that of air, changes with the H. V. L. of the radiation. The dotted branch of the curve is corrected for the attenuation of the beam in the wall (thickness 0.45 mm); it gives the efficiency for the radiation actually entering the chamber. The different regions discussed in the foregoing paragraphs are clearly illustrated by this curve: efficiency of 100 % for very soft radiation as far as it enters the chamber; low efficiency in the region of photo-absorption and predominant ionization by secondary electrons released in the wall; and an efficiency o 108 % for hard radiation (Compton effect in a material with relatively high hydrogen content). The curve has a large, practically flat, part between H. V. L. of 0.04 and 3 mm Al, as the absorption in the window is compensated by the transition of ionization by wall-electrons to that by air cavity electrons.

There are two methods of making thimble chambers for Grenz rays which are practically independent of wavelength:

a. The ionization chamber is made of a material which is perfectly air equivalent. The conductive coating should also be air equivalent; graphite or aquadag is inadequate. The chamber must be provided with a window that is so thin as to make absorption negligible. This means that for Grenz rays the window thickness should not exceed 10 or 20 microns (including the conductive coating). These very thin windows have the disadvantage that they are very vulnerable and have, moreover, a tendency to warp so that a constant volume is not guaranteed. Such a chamber has an efficiency of approximately 100 % (Fig. 7, curve I).

b. A more rigid chamber can be obtained by using for the wall and the coating materials, which have an effective atomic number lower than that of air. It is possible to choose a wall-thickness of such a chamber that the absorption of soft radiation by the wall is compensated by the increased efficiency obtained. Care should be taken that the smallest dimension of the ionization chamber is such that, for that radiation quality (H. V. L.) where the transition between ionization mainly due to wall electrons and ionization mainly due to air-cavity electrons takes place, the attenuation by the wall becomes noticeable. The hardness of the radiation at the transition point is determined by the fact that at this point the average range of the secondary electrons in air is approximately equal to the average length of the trajectory from one

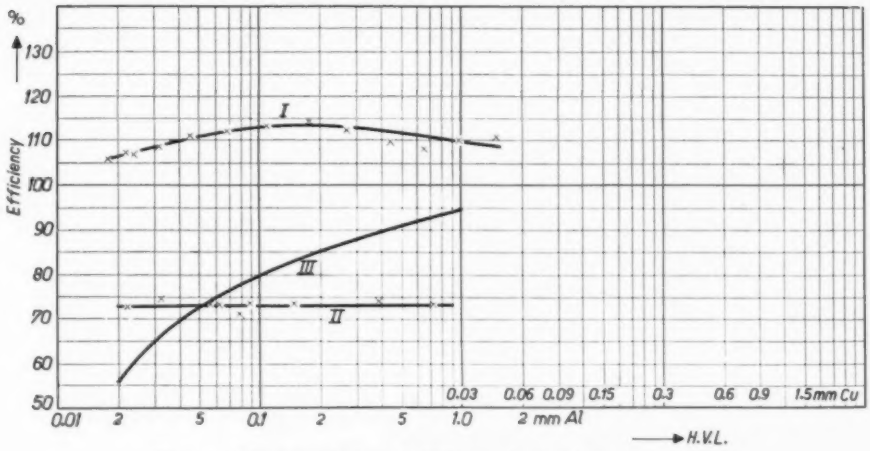

Fig. 7. Characteristics of different ionization chambers.

Curve I: Flat chamber of electrically conducting air equivalent material (loaded bakelite); polystyrene window 20 μ thick, with conductive coating of aquadag with admixture of silicon; electrode spacing 0.75 mm.

Curve II: flat polystyrene chamber with electrodes of aquadag; window thickness 0.18 mm.; electrode spacing 1.80 mm.

Curve III: commercial black nylon chamber of thimble-shape.

electrode to the opposite one.[1] The larger the depth of the chamber, the harder the radiation at the transition point will be; the heavier the wall thickness can and should be to obtain the desired compensation effect, the larger the deviation from complete compensation will be for extreme soft radiations.

The most practical solution for the shape of the chamber is to have two parallel walls at a distance of the order of 1 mm, each forming one of the electrodes. In such a chamber the smallest dimension is uniform, and since the window is flat, the absorption in it also is constant,

[1] This is confirmed by fig. 5 (dotted curve). In the case of fig. 5 the efficiency at the transition point, where the contributions to the ionization current by wall photoelectrons and air cavity photoelectrons are equal, is $\frac{100+64}{2} = 82\ \%$. A radiation quality of 0.05 mm Al H. V. L. is associated with this efficiency; this corresponds to a wavelength of 1.5 Å and an energy of the photoelectron of 7.5 keV. According to data published by Madame CURIE (1), the *maximum* range in air of a 7.5 keV electron is 1.2 mm; the *average* range is approximately 20 % smaller: 0.95 mm. If we assume that the average electron trajectory makes an angle of 45° with the electrode surface, the average length of the trajectory between the two electrodes will be $\sqrt{2}$ times its spacing and amounts to 0.9 mm, which is about equal to the average electron range at the transition point.

Moreover an advantage is gained in that the electric field is uniform and that the ions have to travel only a few tenths of a mm before reaching the collecting electrodes. Therefore a saturation current for high dose rates is obtained at a relatively low voltage between the electrodes; 50,000 r/min. at 20 V, if the spacing between the electrodes is 0.65 mm. The characteristics of such chambers are shown in fig. 5 and fig. 7 (curve II), together with the characteristic of a nylon chamber of the conventional thimble shape (curve III, which is in good agreement with measurements by DAY (3)).

Our thanks are due to Mr. C. VAN OSENBRUGGEN for his help in building the standard chamber.

SUMMARY

A free-air ionization chamber is described for roentgen radiation with a H. V. L. between 0.02 and 1 mm Al. A dose rate of 50,000 r/min. can easily be measured.

Rigid thimble ionization chambers can be made with relatively thick windows (0.2 mm and 0.45 mm respectively) and wavelength-independent between 0.02 and 1 mm Al and between 0.04 and 2.5 mm Al H. V. L. respectively. The wavelength independency is obtained by using for the wall a material that has an effective atomic number lower than that of air. By a suitable combination of window thickness, depth of the (flat) ionization chamber and effective atomic number of the wall material, the variations, as a function of the radiation quality, in the attenuation of the beam due to the chamber window and in the contribution to the ionization through secondary electrons released in the chamber wall compensate each other.

Dose rate and absorption curves in aluminium of a tube with mica-beryllium window (inherent filter equivalent to 40 μ Al) for 11, 16.5, 21.5, 31.0 and 49.5 kV DC, measured with these ionization chambers, are shown.

ZUSAMMENFASSUNG

Es wird eine »Frei-Luft» Ionisationskammer für Roentgenstrahlung mit einer H. W. S. zwischen 0.02 mm und 1 mm Al beschrieben. Eine Dosisleistung von 50,000 r/min. kann leicht gemessen werden.

Robuste Fingerhutkammern mit verhältnismässig grosser Wandstärke (0.2 mm bzw. 0.45 mm), welche wellenlängenunabhängig sind zwischen 0.02 mm und 1 mm Al bzw. zwischen 0.04 und 2.5 Al mm H. W. S. wurden realisiert. Diese Wellenlängenunabhängigkeit wird erreicht, indem für die Kammerwand ein Material verwendet wird, das eine kleinere effektive Atomnummer hat als Luft. Durch eine passende Wahl von Fensterstärke, Tiefe der flachen Ionisationskammer und effektiver Atomnummer des Wandmaterials können die wellenlängenabhängigen Änderungen der Strahlenschwächung durch die Kammerwand und des Anteils der Ionisation, der von Wandelektronen ausgelöst wird, einander kompensieren.

Dosisleistung und Schwächungskurven in Aluminium für eine Roentgenröhre mit Mika-Beryllium Fenster, welche eine Eigenfilterwert hat equivalent mit 40 μ Al, wurden mit dieser Ionisationskammer gemessen für 11, 16.5, 21.5, 31.0 und 49.5 kV konstante Spannung.

RÉSUMÉ

Une chambre à ionisation standard pour des rayons roentgen mou avec une couche de demi-absorption de 0.02 à 1 mm Al est décrite. On peut mesurer avec cette chambre facilement 50,000 r/min.

Il est possible de construire des chambres à ionisation rigide avec des épaisseurs de la paroi de 0.2 mm et 0.45 mm respectivement qui sont indépendentes du longueur d'onde de 0.02 mm à 1 mm Al et de 0.04 à 2.5 mm Al couche de demi-intensité respectivement. Cette indépendance de longueur d'onde est obtenu en employant pour la paroi de la chambre des matériaux qui ont un nombre atomique effectif plus petit que cel de l'air. Par une combinaison bien adaptée de l'épaisseur de la paroi, de la profondeur de la chambre à ionisation plate et du nombre atomique effectif de la paroi, on peut réaliser que la variation avec la longueur d'onde de l'atténuation de la radiation par la paroi de la chambre et de la contribution de l'ionisation par des électrons secondaires relachés dans la paroi, se compensent.

Le débit et des caractéristiques d'absorption dans l'aluminium d'un tube à rayon roentgen avec une fenêtre, composée d'une combinaison de mica et de beryllium (filtre aequivalent à 40 μ Al) sont mesurés avec les chambres à ionisation décrites pour une tension de 11, 16.5, 21.5, 31.0 et 49.5 kV, tension constante.

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FROM ROTTERDAM RADIOTHERAPEUTIC INSTITUTE, PHYSICS DEPARTMENT,
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A GRID IONISATION CHAMBER OF SPECIAL DESIGN FOR THE MEASUREMENT OF SOFT RADIATIONS

by

A. Somerwil

The increasing use of Grenz-ray apparatus in this country has given rise to a demand for accurate calibration of the instruments suitable for measuring dosage rates of soft rays.

Matters are complicated by the fact that many modern Grenz-ray machines are »combined instruments», the beryllium windows of their tubes making them strong enough to withstand higher tensions, so that in addition to Grenz-ray therapy these tubes may be used for deeper therapy as well.

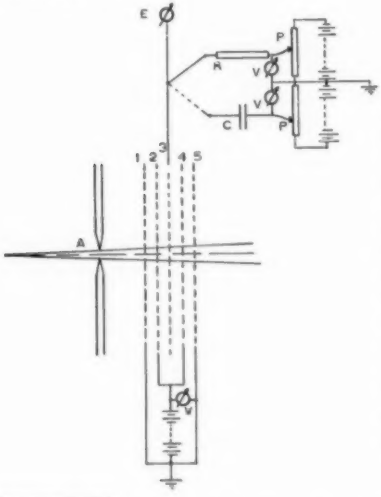

Fig. 1. Diagram of the ionisation chamber and the measuring circuits. Through the aperture A the beam enters a metal chamber with removable walls on which the 5 parallel nylon grids hang. Grid nr. 3 is connected to a den Hartog-Muller dynamic electrometer E (by means of a polythene insulated cable) and either to the high resistance R for routine measurements or, for high accuracy measurements, to the condenser C. P are potentiometers, V voltmeters. E is kept at or near earth potential, and used as a null instrument. The grids are equidistant, otherwise nrs. 1 and 5 cannot be earthed, but must be kept at such a potential that the field on both sides of 2 and 4 is symmetrical.

Submitted for publication, Sept. 7, 1951.

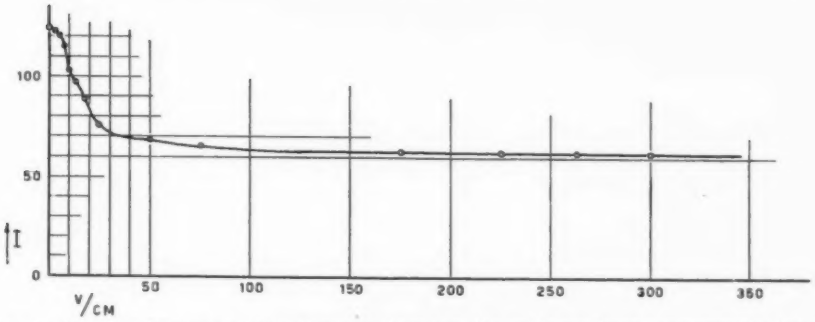

Fig. 2. The irradiation and the distances between the grids are kept constant; the intensity of the electric field between grid nr. 3 and 2, 4 is kept at 300 V/cm. The diagram shows the ionisation current measured as a function of the intensity of the electric field of opposite direction between the grids 1, 5 and 2, 4. All distances between the grids are 2 mm. At 200 V/cm I is within 1 % of the value at 300 V/cm.

As these higher tensions applied to the tube, not only generate more penetrating rays but also greatly enlarge the original intensity of the soft components of the roentgen ray spectrum, therapists sometimes use higher tensions with unfiltered beams for grenz-ray therapy, especially where short exposure times are desired and the most penetrating rays are presumed to do little damage. Consequently, the mixture used is very heterogeneous, which presents certain dosimetric difficulties.

The main problem of Grenz-ray standard dosimetry with a free-air parallel-plate chamber of usual pattern lies in the absorption in air, so that the beam leaving the ionisation measuring volume has an intensity appreciably less than that due to the inverse square law. In the second place great intensities will demand strong electric fields to cause saturation. The potential difference between the plates can be kept within reasonable limits by making the distance between them as small as the range of the electrons generated in the air will permit. Now the presence of harder photons in the beam will make it necessary to keep the plates several centimeters apart, which implies the use of impractically high potential differences in the chamber.

To avoid the difficulties mentioned above a chamber was constructed on the combined principles of the extrapolation chamber (FAILLA) and the mesh chamber (QUIMBY, CLAY a. o.).

The ionisation volume, in which the ions of one sign are collected, is limited in the direction of the beam by two grids (fig. 1). Halfway between these a third grid acts as collecting electrode. The latter is kept on or near ground potential; the former two are kept above saturation potential. The two grids are movable in the direction of the beam; by ap-

proaching the collecting electrode, the ionisation volume they include decreases and extrapolation to zero volume is possible.

The grids are made of fine carbon-coated nylon threads (kindly provided by the AKU Works, Ede, Holland) 50 μ in diameter and 1 mm apart, mounted in thin aluminium frames. The distances between the grids are determined by measuring a 10 × enlarged image of the sides of the frames, projected on a screen.

To make sure that no ions from outside the outer grids are drawn into the collecting field the number of grids is extended to five. The two extra grids, nrs. 1 and 5, are earthed and put in such a position that the electric field on both sides of grids nrs. 2 and 4 is symmetrical. Fig. 2 illustrates their usefulness.

The influence of the shadow of the grids on the ionised volume of air was determined by doubling the number of threads in grid nr. 2 per unit area. The difference lies within the limits of experimental error.

Fig. 3 shows a number of extrapolation curves, found while measuring the absorption in air of the rays emitted by a Machlett AEG 50 tube with beryllium window.

The ionisation current is measured in the way illustrated in fig. 1. For high intensities the high resistance circuit is used; for accurate measurements, however, the compensation method using a calibrated condenser must be preferred.

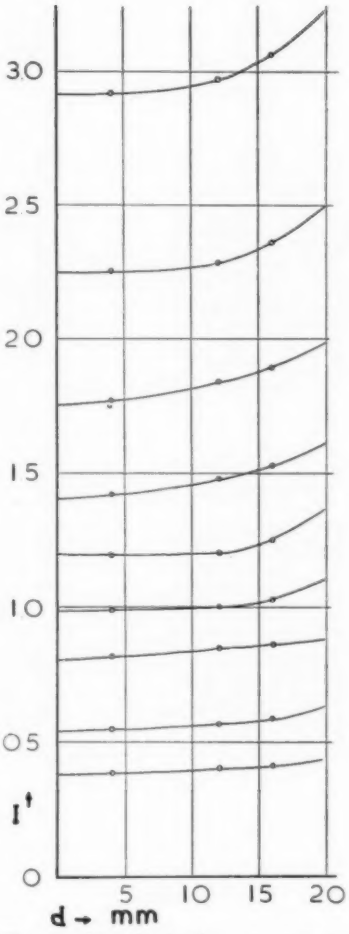

Fig. 3. The ionisation current, in arbitrary units, as a function of the distance between the outer grids of the ionisation volume, at increasing distances from the roentgen tube. The upper curves are nearest to the tube. 10 KVP.

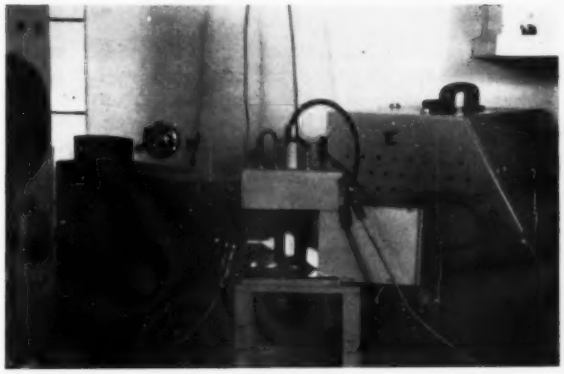

Fig. 4. The chamber with one of the walls removed. The sides of the frames of the five grids are illuminated by a strong lamp for projecting their enlarged image on a screen. N is a needle for accurate positioning of ionisation chambers on the bench; W is the window of the roentgen tube. E is the dynamic electrometer.

Fig. 5. The distances between the grids are measured.
A = arc lamp, L = lens, S = screen.

The accuracy of the measurements is estimated as follows:

Errors in compensation potential	2 ‰
» capacity	3 ‰
» time measurement	3 ‰
diameter aperture	2 ‰
distance between grids	10 ‰
pressure	1 ‰
temperature	1 ‰
Maximum total error	2.2 ‰

SUMMARY

An ionisation chamber was constructed for accurate measurement of the dosage rate of soft radiations in a volume extrapolated to zero. To this end the mesh- and extrapolation chamber principles were combined while a special device was introduced in order to keep the measuring volume free from unwanted ions. The influence of such a device is shown in a graph.

ZUSAMMENFASSUNG

Es wurde eine Ionisationskammer für genaue Dosismessungen von weichen Röntgenstrahlen gebaut, gegründet auf den vereinigten Wirkungsprinzipien der Gitter- und der Extrapolationskammer. Eine Spezialvorrichtung für Abschirmung des verschwindenden Messvolumens gegen unerwünschten Ionen wurde beschrieben und ihre Zweckmässigkeit graphisch dargestellt.

RÉSUMÉ

Une chambre d'ionisation pour le mesurage précis des rayons roentgen mous était construite sur une combinaison des principes de la chambre à extrapolation et de la chambre avec grille. Une disposition spéciale pour empêcher les ions indésirables d'entrer dans le volume de mesurage était appliquée; son avantage est indiqué sur un diagramme.

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A SHORT NOTE ON THE CALIBRATION OF GRENZ-RAY DOSIMETERS

W. J. Oosterkamp and *A. Somerwil*

In the interest of users of dosimeters with Grenz-ray chambers in Holland and in compliance with the recommendations of the International Commission on Radiological units (1950), the authors compared their laboratory instruments described in the preceding articles.

For the present the comparison was restricted to the Grenz-ray region at comparably low intensities.

The results are as follows:

HVD	r/min	ratio Eindhoven / Rotterdam
0.030 mm Al	250	101.5
0.030 » »	110	97
0.045 » »	70	100.7

The differences may be said to lie within the limits of experimental error.

Philips Research Laboratories, Eindhoven and Rotterdam Radiotherapeutic Institute, Physics Dept.

FROM THE GYNECOLOGY DEPARTMENT (DIRECTOR: H.-L. KOTTMEIER) OF THE RADIUMHEMMET, STOCKHOLM, SWEDEN

CANCER OF THE CORPUS UTERI AND THE OVARY IN THE SAME PATIENT

by

Åke B. V. Rydén

The accumulation of cases of female genital cancer in the radiotherapeutic centres has been followed by a demand for a classification system more detailed than that adopted in 1928 (1) by the Radiological Subcommission of the Cancer Commission of the League of Nations Health Organisation.

The object of this paper is to call attention to the type of case in which the patient develops a carcinoma of the uterus and the ovary either coincidentally or at different times. The results obtained by the various methods of treatment used in cancer of the corpus and cancer of the ovary cannot be reliably compared unless a system of grouping is worked out which embraces a satisfactory classification of the cases which cannot be safely placed in either of the two groups »cancer of the corpus uteri» and »cancer of the ovary». A system for the classification of such cases has emanated from the Radiumhemmet and was published in 1948 (2). It has been based on experience gained in the cases discussed in this paper.

Material

The series presented comprises all patients with carcinoma of both the uterus and the ovary treated at the Radiumhemmet from 1914 to 1943. They are 106 in number. Only the cases in which carcinoma of the uterus and of one or both ovaries has been microscopically verified are included.

In order to facilitate the analysis of these cases it has been found convenient to group them as follows:

Submitted for publication, July 27, 1951.

Group 1. Twenty-five patients primarily treated for cancer of the ovary and subsequently for cancer of the corpus uteri.

Group 2. Thirty-one patients primarily treated for cancer of the corpus uteri and subsequently for cancer of the ovary.

Group 3. Fifty patients with coincident cancer of the corpus uteri and the ovary.

Table 1

Age Distribution

Age in years	Group 1	Group 2	Group 3	Groups 1, 2 and 3
20—29			1	1
30—39	3	3	4	10
40—49	13	6	13	32
50—59	6	16	22	44
60—69	3	6	8	17
70 -			2	2

Table 2

Site of the Ovarian Carcinoma

Site	Group 1	Group 2	Group 3	Groups 1, 2 and 3
Right ovary.....	7	12	24	43
Left ovary	12	13	12	37
Both ovaries	6	6	14	26

An interesting feature of the cases was the late onset of the *physiological menopause* before treatment (69 patients). In Sweden, the average age at which menstruation usually ceases, is 48.5 years. In this series the corresponding figure was 50.3 years; in 75.3 per cent of the 69 cases above the patient was 50 years or older.

Group 1.

This group includes 25 cases. The following types may be distinguished:

1. Seven cases of carcinoma of the ovary; submitted elsewhere to bilateral oophorectomy (preserving the uterus) and post-operative roentgen treatment. Carcinoma of the corpus was discovered on a later occasion; irradiated at the Radiumhemmet.

2. Three cases of carcinoma of the ovary; submitted elsewhere to bilateral oophorectomy (preserving the uterus); post-operative radio-

logical treatment at the Radiumhemmet. Carcinoma of the corpus was diagnosed on a later occasion at the Radiumhemmet; in one of these cases hysterectomy was performed; two were treated radiologically.

3. Four cases of carcinoma of the ovary in which bilateral oophorectomy (preserving the uterus) was carried out elsewhere; no post-operative radiological treatment. Involvement of the corpus was diagnosed on a later occasion; two of these cases were treated by irradiation at the Radiumhemmet; in the other two hysterectomy was performed elsewhere and postoperative treatment was given at the Radiumhemmet.

4. Eight cases of carcinoma of the ovary; submitted to unilateral oophorectomy elsewhere, the uterus and one ovary preserved. Three patients received post-operative roentgen treatment at the hospital in which the operation was performed; two were given post-operative radium and roentgen treatment at the Radiumhemmet.

Carcinoma of the corpus was diagnosed on a later occasion. Treatment: hysterectomy in four cases, followed by post-operative radiological treatment at the Radiumhemmet in three cases; radiological treatment at the Radiumhemmet in four cases.

In 6 cases one ovary was preserved because operation was carried out following the diagnosis of »cystoma of the ovary» and malignancy was not suspected before microscopical examinations of the specimens removed. In one case the patient was a young woman, and in the remaining case the reason is not stated.

In 6 cases the patient developed a carcinoma in the remaining ovary (in 4 cases after the treatment of the cancer of the corpus); in 5, the second ovarian carcinoma was more or less removed by surgery.

5. Two cases of carcinoma of the ovary in which unilateral oophorectomy was carried out elsewhere, preserving the uterus. One ovary was left, because it appeared, macroscopically, to be unaffected. Subsequently it was also involved and removed. Neither pre-operative nor post-operative radiological treatment was given. Both patients later developed a carcinoma of the corpus which was treated by irradiation at the Radiumhemmet.

In one case one ovary was preserved at the first operation because malignancy was not suspected before the microscopical examination of the specimen removed; in the other one, the reason is not stated.

6. One case of ovarian carcinoma in which an exploratory laparotomy revealed that the growth was inoperable; in addition carcinosis peritonei and ascites were found. The patient received roentgen treatment at the Radiumhemmet. A subsequent curettage disclosed involvement of the corpus. Intra-uterine radium treatment was given following which the patient died of diffuse peritonitis.

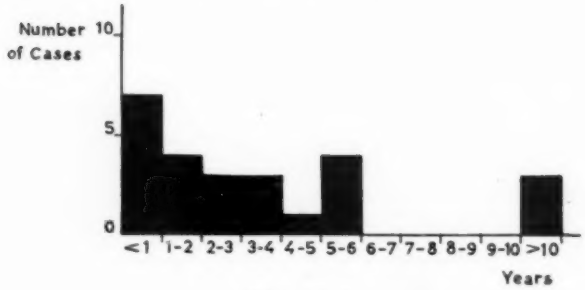

Diagram 1

Time-Interval between Appearance of the Growths in the Ovary and the Uterus.

Group 2.

This group includes 31 cases. The following types may be distinguished:

1. Seventeen cases of carcinoma of the corpus treated by irradiation at the Radiumhemmet. Subsequently, the patients developed a carcinoma of the ovary; they were given pre-operative roentgen treatment at the Radiumhemmet and referred elsewhere for surgical treatment.

In 15 cases bilateral oophorectomy was carried out; in 2 cases only one ovary was removed, the opposite ovary, which was apparently unaffected macroscopically, being preserved. The reason why this was done is not stated. In 8 cases the uterus was also removed. All these patients received postoperative roentgen treatment at the Radiumhemmet.

2. Ten cases of carcinoma of the corpus in which the patient received radiological treatment at the Radiumhemmet. While these patients were under treatment digital examination revealed a mass outside the uterus. The growth was at first not regarded as malignant. Subsequently,however, its character was identified and bilateral oophorectomy was carried out; in 5 cases the uterus was also removed, and in 5 cases the patient received pre-operative roentgen treatment. All patients received post-operative roentgen treatment at the Radiumhemmet.

3. A case of carcinoma of the corpus in which hysterectomy (leaving the adnexa) was performed elsewhere. Post-operative radiological treatment was not given. Subsequently, the patient developed carcinoma of the ovary and was submitted to bilateral oophorectomy at the same hospital where the hysterectomy had been carried out. Post-operative roentgen treatment was given at the Radiumhemmet.

4. Three cases of carcinoma of the corpus in which the patient received radiological treatment at the Radiumhemmet and died of peritonitis or pulmonary embolism while under treatment. The post-mortem examination revealed a carcinoma of the ovary.

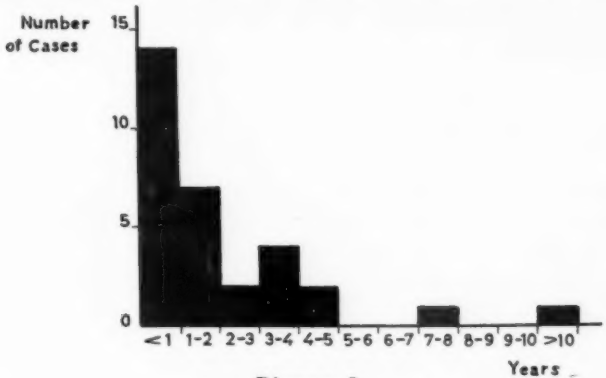

Diagram 2

Time-Interval between the Appearance of the Growths in the Uterus and the Ovary.

Group 3.

This group comprises 50 cases. The following types may be distinguished:

1. Twenty-seven cases of carcinoma of the ovary in which bilateral oophorectomy combined with hysterectomy was carried out. The microscopic examination of the specimens removed showed involvement both of the corpus and the ovary. Three patients operated upon at the Radiumhemmet, were also given pre-operative roentgen treatment. The remaining patients were operated upon at another hospital and did not receive such treatment. All patients received post-operative radiological treatment at the Radiumhemmet.

2. Nine cases of carcinoma of the ovary in which bilateral oophorectomy (preserving the uterus) was carried out (in 7 cases elsewhere, in 2 at the Radiumhemmet). Two of the patients, who were operated upon at the Radiumhemmet, were also given pre-operative roentgen treatment. A curettage done either immediately before or after the operation disclosed carcinoma of the corpus which was treated radiologically at the Radiumhemmet.

3. Six cases of carcinoma of the ovary in which unilateral oophorectomy (preserving the uterus), was carried out elsewhere. One ovary was left because it was apparently macroscopically, unaffected. A curettage done either immediately before or after the operation showed involvement of the corpus. The carcinoma of the corpus was treated radiologically at the Radiumhemmet.

In two of these cases one ovary was preserved because the patient was a young woman, in another because it appeared normal and its removal presented some difficulty owing to adhesions to the bowel. In

the remaining cases the reason is not stated. In three cases the patient subsequently developed carcinoma in the remaining ovary which was surgically removed.

4. Three inoperable cases of coincident involvement of the ovaries and the corpus referred to the Radiumhemmet for post-operative radiological treatment. Following this it was possible to perform bilateral oophorectomy (in one case combined with hysterectomy); the patients were operated upon at the Radiumhemmet and submitted to post-operative roentgen treatment.

5. One case of carcinoma of the ovary, revealed as inoperable at an exploratory laparotomy, with coincident involvement of the corpus. Because of profuse haemorrhage the patient was referred to the Radiumhemmet for radiological treatment although the case was hopeless.

6. Four cases of coincident involvement of the corpus and the ovary in which radiological treatment was initiated at the Radiumhemmet. Three patients died of pulmonary embolism and one of ileus and peritonitis while under treatment.

Table 3

Cure rate after a period of observation of 5 years from the beginning of the treatment of the second neoplasm

Group	Total of cases	Carcinoma of the ovary completely removed by surgery	Carcinoma of the ovary incompletely removed by surgery
1.....	48.0	50.0	33.0
2.....	35.0	45.5	11.0
3.....	44.0	62.0	23.5
1, 2 and 3	42.0	53.5	20.5

Because of the incomplete records it is in many cases difficult to ascertain whether or not the ovarian carcinoma was radically removed and the opinion of the surgeon performing the operation had to be used as a criterion. For this reason it is possible that several cases in which the growth was actually not radically removed were referred to the group »carcinoma of the ovary completely removed by surgery». (Table 3.) On the other hand, it is obvious that the group »carcinoma of the ovary incompletely removed by surgery» does not include any case in which the growth was radically removed. The latter cases, therefore, carry a poorer prognosis than that shown in Table 3.

In 56 per cent of the cases, in which the ovarian carcinoma could not be completely removed by surgery, the patient died of cancer within one year after treatment, and in more than 80 per cent within 5 years.

Table 4

Died of cancer within 5 years after the beginning of the treatment of the second neoplasm

Group	Number of patients	Died within				
		1 year	1—2 years	2—3 years	3—4 years	4—5 years
1.....	10	5	1	1	2	1
2.....	16	11	3	2		
3.....	25	13	7	2	3	
1, 2 and 3...	51	29	11	5	5	1

As stated above, out of 18 cases, in which unilateral oophorectomy was carried out, a carcinoma developed in the remaining ovary in 12 cases. With the exception of one case, in which a growth was discovered after thirteen years, it was generally diagnosed within two years after operation.

In 12 cases a diffuse peritoneal carcinosis and ascites were found at the operation for carcinoma of the ovary. In two of these the patient was alive without evidence of the disease after a period of observation of 5 years. These interesting cases are reported below.

Case Reports

Case 1. The patient, aged 55, was submitted to laparo-centesis because of rapidly increasing ascites. After 7,500 cc of fluid had been removed a large mass was palpated behind the slightly enlarged uterus. The patient was submitted to pre-operative roentgen treatment; 5 × 300 r was administered to each of four abdominal fields covering the entire abdomen. One week later a laparotomy was performed, which revealed a carcinoma of the left ovary, diffuse peritoneal carcinosis and ascites. Bilateral oophorectomy was carried out but the ovarian growth could not be completely removed. Curettage performed immediately after the operation revealed carcinoma of the corpus of the same microscopical type as that of the ovarian growth. The patient was referred to the Radiumhemmet where two intra-uterine radium appplications and one vaginal application were made, followed by two roentgen treatment series at three months' interval; a total dose of 1,200 r was administered to each of two abdominal and two posterior fields. The patient is alive and without evidence of the disease after a period of observation of $8^1/_2$ years.

Case 2. The patient, aged 46, suffered from ascites and a large pelvic tumour. After pre-operative roentgen treatment of 500 r to each of 6 anterior fields, which covered the entire abdomen, laparotomy was carried out which disclosed diffuse peritoneal carcinosis, ascites and bilateral carcinomatous and cystic ovarian tumours with friable cancer tissue on the peritoneal surface. The ovarian growth could not be completely removed; post-operative roentgen treatment elsewhere: three series at three monthly intervals, to 4 abdominal fields which covered the entire abdomen, administering a total dose of 1,500 r to each field.

Six years after treatment the patient developed cancer of the corpus and was treated at the Radiumhemmet with combined intra-uterine and vaginal radium application and roentgen irradiation; 1,100 r to each of two anterior and two posterior pelvic fields.

Eight months later a further 800 r were given to each of the same fields. The patient is alive without any evidence of the disease $12^1/_2$ years after the removal of the ovarian carcinoma and $6^1/_2$ years after the radiological treatment of the carcinoma of the corpus.

All patients with distant metastases died within five years after treatment, mostly within a year.

Discussion

The question whether or not an attempt should be made to classify the types of case presented, depends essentially on the frequency with which they occur in a series of genital cancer cases. If they are of rare occurrence it is not necessary to modify the classification in current use.

The 106 cases of this series constitute 8.4 per cent of all cases of corpus cancer, and 18.6 per cent of all cases of microscopically verified carcinoma of the ovary, treated radiologically at the Radiumhemmet from 1914 to 1943.

The figures indicate that involvement of the uterus and the ovary in the same patient is quite frequent. As long as these cases are arbitrarily classified »carcinoma of the corpus uteri» or »carcinoma of the ovary» it is not possible reliably to estimate the relative value of the methods of treatment used by comparing the results obtained. For this reason the cases should be referred to a special group. At the Radiumhemmet they have long been placed in a group labelled »cancer uteri et ovarii». The use of this nomenclature has been suggested in the »Annual Report of the Results of Radiotherapy in Cancer of the Uterine Cervix» (Vol. 5).

Classification problems, however, are not solved by introducing this group. In the cases in which there is an interval between the clinical appearance of the first and the second growth the clinician is confronted with the problem whether the later growth is a metastasis or a new primary tumour. Should the patient develop carcinoma of the corpus after removal of an ovarian carcinoma, most clinicians will probably consider the uterine carcinoma as metastatic, particularly if there has been only a short interval between the two events. The longer the interval the more likely it is that the uterine carcinoma will be regarded as a new primary tumour.

It might be argued that the microscopic examination of the tumours should permit their correct classification. In most cases, however, the pathologist is not able to say whether there are two primary growths present or whether one or the other is metastatic. In none of the cases of groups 1 and 2 of this series the microscopic examination was able to provide such information. In 4 cases of group 3 the pathologist strongly suggested the presence of two primary tumours, and in another 2 cases he ventured to state which growth was the primary focus and which was metastatic. Even in these cases, however, the conclusions must be

regarded with some reserve. This means that the microscopic examination in most of these cases does not provide the required information.

Thus the time-interval between the two events should be the determining factor in classifying them. It remains to decide on the length of the interval after the lapse of which the second neoplasm should be considered as a new primary growth. The graphs referring to groups 1 and 2 (diagrams 1 and 2) show that the second tumour is usually observed within five years after the diagnosis of the first one. In view of this observation it would seem suitable to choose a five year interval. Moreover, there is reason to believe that a definite cure of the first tumour has been obtained in a number of patients alive without evidence of the disease for 5 years, as is the case in cancer of the cervix. This may be an additional advantage in accepting a 5-year interval.

If the second neoplasm be discovered within the 5-year period and microscopical evidence is available that the organ involved did not show any signs of malignancy when the first one was treated, it should be regarded as a metastasis. If such evidence be not available, *i. e.* if no diagnostic curettage was carried out, it is reasonable to assume that the organ involved later was actually already affected at that time and to classify these cases as »cancer uteri et ovarii»; any second tumour discovered five years or later after the beginning of the treatment of the first should be regarded as a new primary tumour. In order to be able to ascertain whether or not there is coincident involvement of the corpus uteri in cases of carcinoma of the ovary it is advisable to do a diagnostic curettage before treatment is begun. This will lessen errors in diagnosis.

It is clinically not possible to classify a case of carcinoma of the corpus in which there is a tumour, the character of which cannot be determined, lying extrinsically to the uterus. If the carcinoma of the corpus be treated radiologically and at a later occasion microscopic evidence is provided that the extrinsic tumour is an ovarian carcinoma — which indicates that the ovary was already involved when the uterine tumour was diagnosed — the case should be classified as »cancer uteri et ovarii», independently of the period of time within which the character of the second growth was determined.

In conformity with the above principles the following types of case are classified as »cancer uteri et ovarii» at the Radiumhemmet:

1. Cases in which there is a coincident carcinoma of the corpus uteri and the ovary.

2. Cases of cancer of the ovary operated upon but not curetted and developing a carcinoma of the corpus within 5 years.

3. Cases radiologically treated for cancer of the corpus and with a tumour extrinsic to the uterus which later on proves to be an ovarian carcinoma.

Of 106 cases of this series 79 cases were classified at the Radiumhemmet as »cancer uteri et ovarii» (Group 1: 16 cases. Group 2: 13 cases. Group 3: 50 cases).

It is not within the scope of this paper to discuss the methods of treatment and the results obtained. A few interesting points, however, may be mentioned.

The prognosis in the cases in which both the corpus and the ovary were involved, was much worse than in those in which only the corpus was affected and the chances of cure were about the same as in the cases of carcinoma of the ovary. The prognosis depends essentially on the question whether or not the ovarian growth could be completely removed by surgery.

The observations made in this study substantiate the risks of preserving a macroscopically intact ovary in cases of carcinoma of the ovary; there is always the danger of cancer developing at a later date in the remaining ovary. The apparently normal remaining ovary should not be left in situ unless on the special request of the patient.

The following technique of roentgen treatment was used at the Radiumhemmet in the cases under discussion: three series of treatments at three months' interval were usually given, constituting a total dose of 2,500—3,500 r to each of two anterior and two posterior pelvic fields. No evidence was provided that large doses improved the results. As it is not possible to calculate the depth dose at the site of the ovarian carcinoma in any individual case no comparative study of the therapeutic values of large doses was made.

I should like to express my deep gratitude to Professor JAMES HEYMAN, former director of the Gynecology Department of Radiumhemmet, for his great interest and help in planning this investigation.

SUMMARY

The classification of cases of carcinoma of the corpus uteri and the ovary in the same patient is discussed and conclusions presented, based upon a material of 106 cases.

ZUSAMMENFASSUNG

Die Klassifizierung von Fällen mit Carcinoma corporis uteri und Carcinoma ovarii bei einer und derselben Patientin wird diskutiert. Schlussfolgerungen, basiert auf einem Material von 106 Fällen, werden vorgelegt.

RÉSUMÉ

L'auteur discute la classification des cas présentant simultanément un cancer du corps de la matrice et des ovaires. Il présente des conclusions basées sur un matériel de 106 cas.

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FROM THE GENERAL DEPARTMENT OF RADIUMHEMMET (DIRECTOR: PROF. H. AHLBOM)
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STERNAL PUNCTURE IN SARCOIDOSIS

by

Lars-Gunnar Larsson and *Sixten Franzén*

The bone marrow of the fingers and toes is often affected in sarcoidosis, and the granulation tissue occasionally causes typical roentgenological bone changes. Bone destruction in other situations has also been described, but appears to be uncommon. The examination of certain cases at autopsy has nevertheless shown that the microscopic changes in the bone marrow may be very extensive (SCHAUMANN, NICKERSON, and others). It should, therefore, sometimes be possible to demonstrate such changes in the sternal punctate. Whereas earlier writers (DRESSLER and STAHEL, ESSEN and LINDEGAARD NIELSEN) reported only single cases, GORMSEN, who found granulomas in the sternal bone marrow in 10 out of 39 cases, showed that the method might be of practical diagnostic importance. Positive findings were made in histological sections of the bone marrow, whereas it was not possible to demonstrate cytological elements of the disease in ordinary smears. Recently, however, HOVDE and SUNDBERG have described a case of sarcoidosis in which they succeeded in finding epithelioid cells in smears of the sternal punctate. The fact that negative results are also often obtained in the first-mentioned technique is shown by LEITNER's statement that he examined sections of the sternal bone marrow from 21 patients with sarcoidosis without finding granulomas.

Since 1949, we have examined sections of the sternal punctate from 11 patients with sarcoidosis; in 4 of them typical epithelioid cell granulomas were present. The following reports appear justified in view of the fact that this diagnostic possibility still appears to be relatively unknown.

Technique. Visible particles of bone marrow in the punctate were placed on a watch glass and collected together. Ordinary histological fixation fluid was then poured over the punctate. This resulted in a confluent preparation, which was sectioned after being

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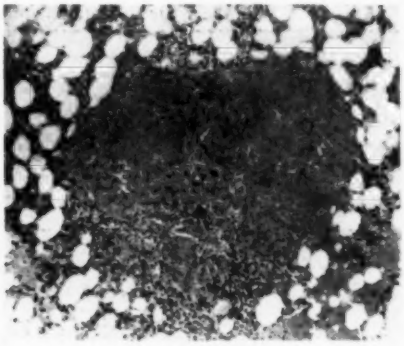
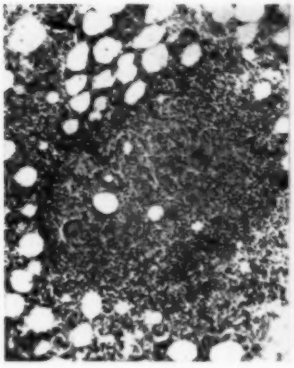
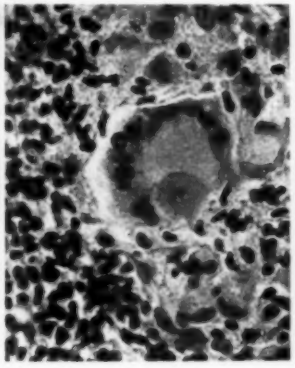


Fig. 1. Fig. 2.

Fig. 1. Case 1. Bone lesions in the terminal phalanx of the right thumb.
Fig. 2. Case 1. Epithelioid cell granuloma — sternal bone marrow. 65 ×.





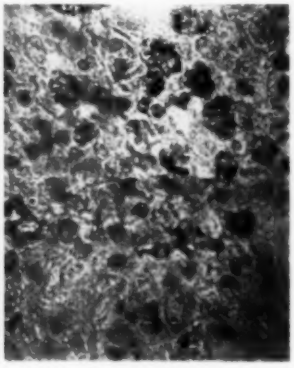


Fig. 3. Fig. 4. Fig. 5.

Fig. 3. Case 2. Epithelioid cell granuloma — sternal bone marrow. 65 ×.
Fig. 4. Case 2. Detail of the same granuloma with a Langhans' giant cell, epithelioid cells and lymphocytes. 360 ×.
Fig. 5. Case 2. Agglomeration of eosinophil cells in the vicinity of a granuloma. 570 ×.

embedded in paraffin. The sections were stained with haematoxylin and eosin, Giemsa's method and Ziehl-Neelsen's tubercle bacilli stain.

In the 7 cases in which the findings in the sternal punctate were negative, the diagnosis of sarcoidosis had earlier been verified histologically and clinically. The following is a brief account of the 4 cases in which the findings were positive.

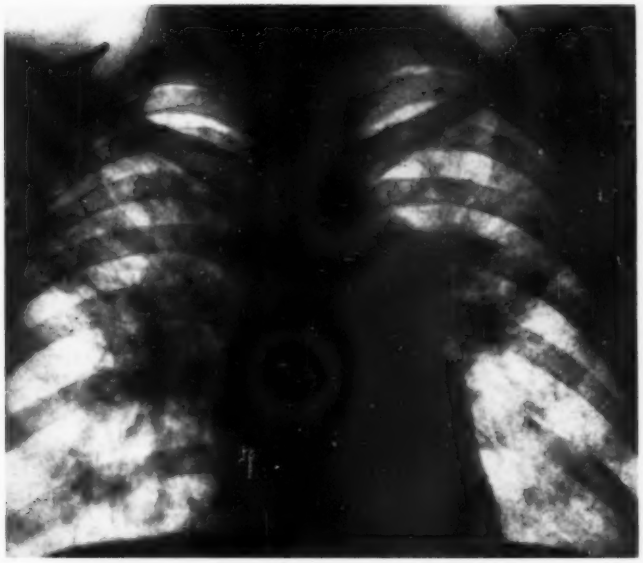


Fig. 6. Case 3. Roentgenogram of the lungs.

Case 1. 10049/45. A man, aged 39, with bilateral hilar lymphomas, disseminated densities in the lungs, roentgenologically demonstrable lesions in the fingers and toes (Fig. 1) and multiple skin sarcoids. The Mantoux reaction was negative (1 mg). The diagnosis was microscopically verified (specimens from the lymph nodes, tonsils, skin lesions and sternal bone marrow).

Case 2. 1785/50. A man, aged 47, with bilateral hilar lymphomas, streaky densities in the lungs, lesions in the mucosa of the nasal cavities and nasopharynx and skin sarcoids on the ears and nose of the lupus pernio type. The Mantoux reaction was positive (0.1 mg). The diagnosis was verified microscopically (specimens from the tonsils, nasopharynx and sternal bone marrow). The patient subsequently died of generalized tuberculosis.

Case 3. 11918/50. A man, aged 45, with marked hepatosplenomegaly (Fig. 7), bilateral hilar lymphomas and bilateral streaky densities in the lungs (Fig. 6). Microscopic verification (sternal bone marrow); earlier microscopic verification was lacking.

Case 4. 1265/51. A woman, aged 60, with preauricular and cervical lymphomas on the right side and a slightly increased network of markings in the pulmonary fields. The Mantoux reaction was positive (0.1 mg). The diagnosis was verified microscopically (specimen from sternal bone marrow and subsequently also in a specimen from a preauricular lymph node).

Fig. 7. Case 3. Roentgenogram showing considerable splenomegaly.

In all the cases described, there were small, round epithelioid cell granulomas, with a variable, peripheral infiltration of lymphocytes and a few Langhans' giant cells in the sternal bone marrow (Figs. 2, 3, 4, and 8). In Cases 1, 2, and 4, a marked agglomeration of eosinophil cells was present in the immediate vicinity of the granuloma (Fig. 5), as noted by GORMSEN in some of his cases. Necroses were not found in any instance, but fairly marked hyalinization was present in one of the granulomas in Case 2. No tubercle bacilli were encountered in specially stained sections. Examinations were made of ordinary bone-marrow and blood smears, but no definite changes could be demonstrated. Roentgenographic examinations of the bones of the hands and feet were carried out in every case; definite bone lesions were found in Case 1 only.

Disseminated epithelioid cell granulomas in the bone marrow have earlier been considered to occur in three diseases, *i. e.*, sarcoidosis, miliary tuberculosis and brucellosis (*cf.* GORMSEN). Recently, however, HOVDE and SUNDBERG have demonstrated that granulation tissue containing epithelioid cells may often also be found in sections of the bone marrow punctate in infectious mononucleosis. In sarcoidosis and miliary tuberculosis, the granulomas are, as a rule, round and fairly well-defined. Necroses in the granulomas occur at times in miliary tuberculosis and it may be possible to demonstrate tubercle bacilli in specially stained sections. In the granulomas of sarcoidosis, necrosis is usually absent whereas different degrees of hyalinization and fibrosis may be present. It is, however, often impossible to distinguish between these granulomas and miliary tubercles from the histological picture alone. In brucellosis and

infectious mononucleosis, the granulomas are usually more irregular in shape and less sharply defined.

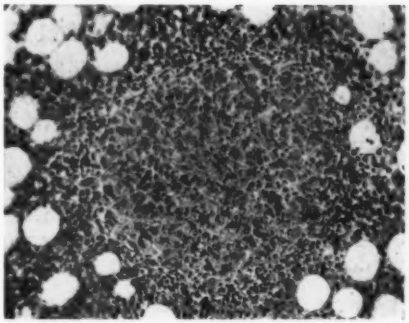


Fig. 8. Case 3. Epithelioid cell granuloma — sternal bone marrow. 130 ×.

The discovery of disseminated, epithelioid cell granulomas in the bone marrow is thus not pathognomonic of any of the aforementioned diseases. However, in conjunction with the clinical picture, it usually permits a definite diagnosis to be made. Of the cases described, there was doubt regarding the nature of the granuloma only in Case 2. This patient not only had clinically and histologically typical sarcoidosis, but active tuberculosis as well; he subsequently died of generalized tuberculosis. However, judging by the clinical picture at the time when the puncture was made and by the histological appearance of the granulomas — partly hyalinized, without necroses and with no demonstrable tubercle bacilli — it is most probable that the pathological changes in the punctate were actually those of sarcoid granulomas.

The demonstration of epithelioid cell granulomas in the sternal bone marrow is of interest as an example of the disseminated nature of the disease. As shown by Cases 3 and 4, the examination may also be of definite diagnostic value; in the latter case, the result gave the first indication of the correct diagnosis; further confirmation was obtained by a specimen from a lymphoma. In Case 3, the roentgenogram of the lungs presented appearances usually found in sarcoidosis although there was at the same time more marked hepato-splenomegaly than is usual in this disease. The observation of granulomas in the sternal punctate was decisive. This case strongly resembles an autopsy case described by FROELICH and SCHERER, in which the pathological picture was dominated by pronounced hepato-splenomegaly and fibrotic pulmonary lesions. Considerable splenomegaly was also present in the first case described, in which granulomas were demonstrated in the sternal punctate (DRESSLER 1938).

SUMMARY

A description is given of four cases of sarcoidosis in which epithelioid cell granulomas were demonstrated in sections from the sternal punctate. Only one of the patients had definite roentgen signs in the bones of the hands and feet.

ZUSAMMENFASSUNG

4 Fälle von Boeckschem Sarkoid werden beschrieben, bei denen Epitheloidzellgranulome im Sternalpunktat nachgewiesen werden konnten. Nur einer dieser Patienten hatte röntgenologische Veränderungen im Hand- und Fussskelett.

RÉSUMÉ

Description de quatre cas de sarcoïdose dans lesquels des granulomes de cellules épithéloïdes ont été décelés dans les préparations à partir de la ponction sternale. Seul, un des malades présentait des signes radiologiques définis dans les os des mains et des pieds.

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DIAMIDINES IN MYELOMATOSIS

by

J. Bichel

Six years have now passed since SNAPPER introduced stilbamidine in the treatment of myelomatosis, and by now it should be possible to form an idea as to its therapeutic value. As I have often been questioned about this form of treatment, the case histories of 10 patients treated with diamidine compounds at the Radium Centre, Aarhus, may be briefly reported. For details concerning the origin and development of the treatment and the chemistry of the compounds the reader is referred to a previous survey in this journal. The compounds which have been used are *stilbamidine* and *pentamidine*.

Stilbamidine is a white powder, which is dissolved in 10 ml of sterile distilled water just before use. The solution is injected intravenously. We have followed SNAPPER's instructions and administered 50 mg on the first day, 100 mg on the second, followed by 150 mg daily or every other day, 15 injections in all being given in a series. The injection should take place slowly because it may cause a fall in blood pressure and even collapse; these complications may be mitigated by 0.5 mg of atropine sulfate given subcutaneously 30 minutes before the stilbamidine. However, the most distressing side reaction is a facial anesthesia in the area supplied by the trigeminal nerve, which may occur several months later. It is a dissociated anesthesia with preserved sensation of pain and is very discomforting to the patient. It seems to be uninfluenced by large doses of thiamine hydrochloride but tends to disappear spontaneously after a few months. A similar neuropathy does not seem to develop after *pentamidine*. For this reason the latter compound, which is reported to have

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a similar beneficial effect in myelomatosis, has lately been used in the place of stilbamidine.

Pentamidine isethionate (*M & B*) is a crystalline powder, which should be dissolved in 10 ml of distilled water before use. The injections which are given *intramuscularly*, 200 mg daily or every other day, are painless and do not produce acute side reactions. Unlike stilbamidine, *pentamidine* has not caused trigeminal neuropathy in our cases. On the other hand, several of our pentamidine-treated patients have become strangely dull and mentally depressed during medication; one even developed a slight psychosis. Such reactions were not encountered in patients treated with stilbamidine. Incidentally, as far as I know, these symptoms have not been mentioned in other reports.

Following SNAPPER's suggestion, the treatment of myelomatosis with these two compounds was combined with a diet low in animal protein. Some of the patients were also given tablets of calcium gluconate and a concentrated preparation of vitamin D. This additional medication has also been carried out in those of our patients with myelomatosis treated with roentgen.

Report of Cases

Case 1. A man, aged 46, who had suffered from pain below both costal margins for 18 months was admitted in November 1945. Roentgen examination disclosed generalized halisteresis of the entire skeleton and numerous areas of rarefaction. Marrow smears: myelomatosis. S. R. 95 mm; no anemia. Total serum proteins 9.8 %, A/G = 4.0/5.8. Roentgen treatment had a beneficial effect on the pain. In Aug. 1946 no pain; a little tired. In Sept. 1946 and Feb. 1947 unchanged condition (S. R. 65 mm, no anemia). In Aug. 1947 pain had recurred in several situations, notably below the left costal margin and in the thorax; progressive fatigue. On re-admission in Oct. 1947 the areas of rarefaction had increased in size. S. R. 132 mm; no anemia, WBC 7,600, differential count: normal, platelets 220,000. Serum proteins 9.2 %, A/G = 3.5/5.7. A series of *14 stilbamidine* injections was given. The pain diminished and the general health seemed to improve slightly. In June 1948 the pain had recurred; the patient complained of progressive fatigue and was dyspneic. A discomforting facial anesthesia, accompanied by itching, had then persisted for more than 3 months. The areas of bone destruction had increased in number and size. S. R. 130 mm, moderate anemia, serum proteins 12.2 %, A/G = = 2.9/9.3. Roentgen treatment to the spine was given with moderate effect on the pain. The patient was very tired on discharge and was not seen again. In Oct. 1949 he was still alive but in a miserable condition.

Case 2. A man, aged 36, had overstrained himself seven years previously by lifting a heavy weight and developed pain in the back, which disappeared after a week in bed. At the age of 32 (1941) destruction of the second lumbar vertebra was found at the Hobro Hospital and plaster-jacket treatment was instituted. Shortly afterwards he underwent plaster-bed treatment and later osteosynthesis (Albee) was carried out with good effect for some time. In 1945 a further operation, at which tissue was curetted from a bone cavity, was performed; histological diagnosis: plasmocytoma. The patient was

transferred to the Radium Centre in April 1945. On admission he had severe pain in the lower part of the back and could only sit up in bed with difficulty. The spine was fixed, with kyphosis of the dorsolumbar region; S. R. 8 mm; no anemia, WBC 6,200, differential count: normal. Marrow smears showed no changes. R. E.: complete destruction of the second lumbar vertebra. Roentgen treatment to the lumbar spine with good temporary effect on pain. Blood examinations in Oct. 1946 and April 1947 showed unchanged conditions. Afterwards intense pain recurred and the patient had to stay in bed. In Aug. 1947 myeloma cells were observed in the marrow smears for the first time. Skeletal changes were shown only in the second lumbar vertebra, which was completely destroyed. The patient was given 15 *stilbamidine* injections, mostly of 150 mg, but a few of somewhat smaller dosage owing to dizziness as they were carried out. However, the pain continued to increase in severity. In Oct. 1947 areas of rarefaction in various bones and a slightly elevated sedimentation rate (29 mm) were observed for the first time. Roentgen therapy to the spine was given with temporary good effect on the pain. In Dec. 1947 a highly discomforting *stilbamidine* anesthesia had developed. The patient was not re-admitted until Aug. 1948. The facial anesthesia persisted unchanged and the patient was constantly confined to bed owing to severe pain. The areas of bone destruction had increased in size and number. S. R. 117 mm. *Pentamidine* treatment was attempted, but the patient became strangely dull and apathic during the treatment which had to be discontinued after 9 injections of 200 mg. The patient continued downhill and died in June 1948. Autopsy confirmed the diagnosis of myelomatosis. Total proteins in the serum a few days before death 7.6 %, A/G = 3.7/3.9.

Case 3. A man, aged 69, was admitted to the Radium Centre in June 1947 with myelomatosis diagnosed one year previously. Roentgen treatment had been given to a lesion in the right clavicle. On admission he was weak but well enough to be up and about. He complained of pain in the right side of the thorax. S. R. 160 mm, Hb. 60 %. RBC 3,060,000, WBC 2,100 (pol. neutr. 61, eos. 5, lymphoc. 25, monoc. 9), platelets 64,000. Bone marrow smears confirmed the diagnosis of myelomatosis. Roentgen examination of the bones showed no other lesion, apart from a slight generalized halisteresis. The area of destruction in the clavicle had partially healed. Total protein in serum 10.3 %. A/G = 3.1/7.2. The patient was given 15 *stilbamidine* injections (75 mg, 50 mg, and 13 × 150 mg). The therapy did not produce definite subjective changes but aggravated the anemia. After the termination of treatment the blood picture was as follows: S. R. 164 mm, Hb. 50 %, RBC 2,460,000, WBC 4,800; serum proteins 10.6 %, A/G = 2.3/8.3.

He was last seen in Sept. 1947. Blood examination at that time: S. R. 155 mm, Hb. 47 %, RBC 2,540,000, WBC 3,800; platelets had fallen to 20,000. He stated he was less tired and had no facial anesthesia and no pain. At home his condition rapidly deteriorated and he died in Nov. 1947.

Case 4. A woman, aged 64, had from the autumn of 1946 suffered from progressive fatigue and pain radiating from the lumbar spine. A diagnosis of myelomatosis was made in another hospital, where she was given roentgen treatment to the thoracic spine and hip regions. During the next few months she became gradually weaker, with pain radiating down the lower extremities, and was finally confined to bed. On admission in June 1947 she was cachectic, weak and could not get out of bed unaided. S. R. 72 mm, Hb. 67 %, RBC 3,200,000, WBC 4,800, differential count: essentially normal, platelets 250,000. Bone marrow: typical myelomatosis. Serum proteins 9.2 %. A/G = 5.8/3.4. Roentgen examinations showed generalized halisteresis and destruction of varying degree throughout the entire skeletal system. A series of 16 *stilbamidine* injections (50 mg, 75 mg, and 14 × 150 mg) was given. She tolerated the treatment well and was discharged

in Aug. 1947. The pain had abated very considerably, and the patient felt much better and was able to be up and about for short periods at a time. On discharge: S. R. 78 mm, Hb. 59 %, RBC 3,140,000, WBC 4,000, platelets 285,000; serum proteins 9.5 %.

She was readmitted in Sept. 1947. She had felt better at first, but on re-admission had pains in the shoulders, thorax, back and hips. Roentgen examination revealed that the areas of bone destruction had increased in size and number. S. R. 80 mm, Hb. 60 %, RBC 2,850,000; serum proteins 10.0 %, A/G = 4.3/5.7. A marked trigeminal anesthesia, accompanied by distressing paresthesias and itching all over the face, had developed. Roentgen treatment relieved the pain but did not otherwise favorably affect her general condition. In April 1948 pain had recurred in various situations. On re-admission the distressing facial anesthesia persisted. S. R. 69 mm, Hb. 42 %, RBC 2,200,000, WBC 3,800; serum proteins 8.1 %, A/G = 3.9/4.2. A series of *pentamidine* injections was commenced, but the patient went rapidly downhill and died a fortnight later.

Case 5. A man, aged 76, was admitted to the Radium Centre in May 1947. He had been confined to bed for the last two months and could rise only with extreme difficulty because of pain in the lower part of the back. Roentgen examination revealed generalized halisteresis and numerous small areas of rarefaction in the pelvis and spine. S. R. 125 mm, Hb. 80 %, RBC 4,040,000, WBC 2,100, platelets 385,000. Bone marrow smears revealed myelomatosis. Total proteins in the serum 9.2 %, A/G = 3.1/6.1. A series of 15 *stilbamidine* injections (75 mg, 100 mg, and 13 × 150 mg) was given intravenously. By the termination of the treatment the pain had completely disappeared, and the patient could get out of bed and walk unaided. Control roentgenograms of the pelvis did not show any definite change. S. R. 141 mm, Hb. 56 %, RBC 2,560,000. The patient recuperated further at home. In Sept. 1947 progressive pain developed in the back and the patient was re-admitted in Jan. 1948. No definite increased bone destruction. He was not so weak as on first admission, but his height had decreased by 9 cm, due to a gibbus formation in the thoracic spine. S. R. 135 mm, Hb. 73 %, RBC 3,400,000. A second series of *stilbamidine* injections (11 × 150 mg) was given. After 6 injections the pain subsided considerably and after 11 injections disappeared completely. After treatment: S. R. 143 mm, Hb. 66 %, RBC 3,220,000. Oct. 1948: Subjective well-being, no pain; April 1949: Slight pain in the right leg; but felt quite comfortable; S. R. 82 mm, Hb. 70 %, RBC 3,190,000, platelets 200,000; serum proteins 9.1 %, A/G = 4.1/5.0. At the last follow-up examination in Oct. 1949 the condition was essentially unchanged. He had slight pain in the left leg but was able to walk about fairly unimpeded. On his way home from the follow-up examination he fell and sustained a fracture of the sternum. Shortly afterwards he developed pneumonia and died.

Case 6. A woman, aged 65, was admitted in Dec. 1946 under observation for intracranial tumor; she had suffered from headache, flickering before the eyes, dizziness and unilateral exophthalmos for some months. At the same time she had had pains in the lumbar region and both shoulders. Roentgen examination revealed areas of destruction in the spine and skull and a fracture of a rib and of the right clavicle. S. R. 30 mm, Hb. 62 %, RBC 3,080,000, WBC 3,700. Indefinite changes were observed in the bone marrow; the number of plasma cells was not essentially elevated, but as slightly atypical forms were present, a diagnosis of myelomatosis was considered. Roentgen irradiation to various bone foci relieved the pain in both arms, but the fatigue and weakness progressed. A compression fracture of the body of the sixth cervical vertebra was discovered; it was treated with roentgen with but temporary relief of pain. The patient was re-admitted in June 1947. The degree of cachexia had increased, and she had intense pain in the left flank. The tongue was smooth and red. S. R. 30 mm, Hb. 48 %, RBC 2,350,000,

WBC 2,800. Rather unexpectedly, marrow smears now revealed a typical megalocytic erythropoiesis and maturation anomalies in the granulopoiesis characteristic of pernicious anemia. Only 4.5 % plasma cells, none atypical. Roentgen examination showed an increase in the number and size of the areas of bone destruction and several spontaneous fractures of the ribs. Achylia was present. As the patient now had typical pernicious anemia, intramuscular injections of a preparation of refined liver were given without any response in the reticulocyte count and general blood picture. A change-over to oral administration of folic acid (*Folvite*, Lederle: 10 mg daily) resulted in a prompt increase in the reticulocytes, and the erythropoiesis became normocytic: the hemoglobin level increased to 86 %, RBC to only 3,320,000. As the diagnosis still seemed rather uncertain, a trephine biopsy of a hazelnut-sized cavity in the skull was performed. This cavity was filled with greyish red tissue, which histologically showed typical *plasmocytoma*. Shortly afterwards flaccid paralysis of the lower extremities developed. *Stilbamidine* therapy was now attempted, but after 10 injections each of 150 mg the paralyses remained unchanged and the extreme fatigue persisted although the pain subsided. The patient was discharged and died in her home a few months later. An examination of the marrow shortly before her discharge showed normal conditions. Serum proteins on discharge 7.1 %, A/G = 3.3/3.8.

Case 7. A man, aged 72, was admitted in Sept. 1948 with progressive fatigue and dizziness of six months' duration. Shortly before admission pain in the left side of the thorax had developed. S. R. 124 mm, Hb. 82 %, RBC 3,860,000, WBC 5,700, platelets 220,000. Bone marrow: myelomatosis. Serum proteins 7.1 %, A/G = 3.7/3.4. Roentgen examination of the skeleton revealed nothing definitely abnormal. A series of 14 *pentamidine* injections (200 mg daily) was given. On discharge: S. R. 117 mm, Hb. 59 %, RBC 3,150,000; serum proteins 6.9 %, A/G = 3.9/3.0. The condition improved at home, but for a few months only; the dizziness and fatigue then recurred, accompanied by a loss in body-weight and pain, notably below the left costal margin. At the same time he began to suffer before re-admission from mental depression and had attacks of weeping, which greatly contrasted to his psyche on first admission. S. R. 149 mm, Hb. 48 %, RBC 2,410,000. He wanted to be discharged and died at home on May 16, 1949.

Case 8. A woman, aged 54, had for about 10 years had a sensation of numbness and muscular weakness in the right leg. Shortly before admission pain developed in both legs, radiating from the knees towards the feet and the hips. She could walk only with the support of sticks and was very tired. S. R. 45 mm, Hb. 65 %, RBC 3,040,000, WBC 3,300, platelets 290,000. Roentgen examination of the bones showed marked halisteresis and numerous areas of rarefaction, notably in the pelvis and skull. The aspirated marrow was abundant in cells, with 20 % plasma cells, and although no atypical forms were present, a diagnosis of myelomatosis was considered fairly certain. The urine contained Bence-Jones protein. *Pentamidine* treatment was instituted and the patient was, as usual in these cases, placed on a diet low in protein; after only 8 injections she declared that she could not stand the diet and wanted to be discharged. On discharge: S. R. 40 mm, Hb. 83 %, RBC 3,840,000. — No definite effect on the pain was observed, but from her subsequent communications the pain apparently increased after discharge; she did not mention any suggestion of anesthesias or paresthesias.

Case 9. A man, aged 40, had had periodic lumbar pain for 2 years and was admitted to the Neurological Department for polyradiculitis. After the disclosure of a destructive lesion in the body of the fifth lumbar vertebra the patient was transferred to the Radium Centre in Nov. 1947. A puncture specimen from the affected vertebral body

revealed myelomatosis. The sternal marrow, however, showed nothing abnormal. S. R. 5 mm, serum proteins 6.6 %, A/G = 4.3/2.3. No anemia; leukocyte and differential counts: essentially normal. Roentgen irradiation to the lumbar spine gave some relief of pain. The patient was discharged in Dec. 1947, but on the way home slipped and fell. He was re-admitted with complete paralysis of the lower extremities. The sedimentation rate was still normal. He was now given 10 *stilbamidine* injections each of 150 mg. The therapy did not produce any effect on the paralysis. Subsequent roentgen treatment to the spine gave some mobility to the legs, but intense pain commenced in the feet. He was re-admitted in May 1948. The paralysis persisted unchanged and a very distressing trigeminal anesthesia over the whole of the left side of the face developed. The sedimentation rate and sternal marrow still showed normal conditions. *Pentamidine* therapy, 200 mg daily or every other day, was instituted. During the treatment progressive fatigue and anorexia set in and the patient began to complain of a sensation of oppression. These symptoms increased in severity and were accompanied by a state of mental depression gradually approaching that of a psychosis. The patient refused further treatment after 8 injections and was discharged without noteworthy improvement of the paralysis. Afterwards treated with a plaster jacket at the Orthopedic Hospital, Aarhus. At the last follow-up examination in that hospital in Sept. 1949 his condition remained fairly unchanged; death ensued in Feb. 1950.

Case 10. A man, aged 57, was admitted in March 1949 with a history of pain in the back of 3 years' duration. At that time the pain, increased by fatigue, had lately become progressively worse, so that he could only get up for a couple of hours daily. S. R. 60 mm, Hb. 95 %, RBC 4,680,000, WBC 3,200. Sternal marrow smears: myelomatosis. Roentgen examination showed halisteresis and small areas of rarefaction of the skull, generalized halisteresis of the spine, and a compression fracture of the body of the first lumbar vertebra. Serum proteins 9.1 %, A/G = 4.9/4.2. The patient was given a series of 12 *pentamidine* injections each of 200 mg. During the treatment the pain in the spine disappeared almost completely, whereas some residual pain persisted in the right leg. The patient could now be up and about all day. Just after the termination of the treatment the blood picture was as follows: S. R. 47 mm, Hb. 70 %, RBC 3,700,000, WBC 4,700. At a follow-up examination in May 1949, 2 months later, he had pain in both legs, but not in the back. He felt a little tired but was, on the whole, better than on first admission. S. R. 91 mm, Hb. 69 %. During the summer progressive fatigue developed, now accompanied by pain in various regions, notably in the upper part of the back between the shoulder blades. On re-admission in Sept. 1949, roentgen examination revealed a fracture of the fifth thoracic vertebra and the areas of skeletal destruction had increased in size and number. He was able to get up but walked with some difficulty. S. R. 114 mm, Hb. 81 %, RBC 3,910,000, WBC 7,600; serum proteins 7.8 %, A/G = 3.2/4.6. *Pentamidine* therapy was repeated, this time with 15 injections of 200 mg each. During treatment the pain abated and the difficulty in walking diminished. Just after the termination of treatment the blood picture was as follows: S. R. 127 mm, Hb. 60 %, RBC 3,160,000: serum proteins 8.15 %, A/G = 3.40/4.75. There had been no facial anesthesia or paresthesias.

Discussion

Pain is by far the most dominant symptom in myelomatosis. Accordingly, the value of a new method of treatment must, in the first instance, be assessed by its analgesic effect. In five of the ten cases reported, definite alleviation of pain was obtained; in two, the degree of relief

was even very pronounced. The relief usually began after 6—7 injections, and at the same time the patients often stated that they felt much stronger. After the disappearance of pain mobility improved. Of two patients who were constantly bedridden on admission, one was partially and the other completely ambulant on discharge. However, the improvement lasted only a few months, but in one case (case 5) the treatment was repeated with equal success. Of the remaining five cases, in two the treatment had to be discontinued (case 6 was already in a hopeless condition on admission; case 8 could not stand the protein-poor diet); two patients (cases 2 and 9) had solitary myelomas in the spine; and one patient (case 3) had no bone pain at the institution of the therapy. Two of the patients (cases 2 and 8) stated that their pain had been aggravated by treatment.

Thus, although the treatment had a fairly pronounced analgesic effect in some of the patients and also produced some improvement in their general condition, it must at once be added that definite objective improvement was not observed. The bone destruction and the halisteresis may have been temporarily arrested, but healing of the osseous lesions was not observed at the frequent follow-up examinations. The sedimentation rate did not fall during treatment, and the increase in serum globulin, which may be supposed to be correlated with the intensity and dissemination of the myelomatous processes, also remained unaffected. The number of myeloma cells in the marrow did not seem to be influenced by the treatment, although basophilic granules in the cytoplasm of the cells described by SNAPPER were sometimes observed. No appreciable disintegration of myeloma cells occurred and no differentiation of cells was observed; BENCE-JONES proteinuria persisted. On the other hand, in several cases a pronounced depression of the hemoglobin level and the erythrocyte count took place; this, however, seemed to clear up shortly after the termination of the treatment.

A slight leukopenia (neutropenia) was occasionally encountered, whereas no definite effect upon the thrombocyte count was seen. But a real arrest of the myelomatous processes should, if anything, be supposed to result in an increase in these values. Further, *stilbamidine* therapy may often cause the aforementioned trigeminal anesthesia, which develops 2—3 months after treatment. Seven of the patients were treated with *stilbamidine*, one of them with two series (case 5). Trigeminal anesthesia developed in four and was a troublesome complication to a severe disease. According to the literature available, *pentamidine* does not cause trigeminal neuropathy or any other untoward reactions. Five of the patients in this case material were treated with *pentamidine* (two of them (cases 2 and 9) had previously been given *stilbamidine*). In none did trigeminal anesthesia develop. On the other hand, a peculiar

emotional change occurred in three patients (cases 2, 7, and 9) during treatment. They became slightly dull, tired, and at the same time mentally depressed, discontented and a little quarrelsome without being able to give any reason for these reactions. They often wept, and their condition almost bore the marks of a psychosis. The changes were very striking in two patients (cases 7 and 9), who were gay, kindly and co-operative before treatment. In one patient (case 8) treatment had to be discontinued after 8 injections owing to opposition to the diet; this may possibly be traced back to a similar incipient emotional change. — Only one patient (case 10) received two series of *pentamidine* injections without any side reactions. Although I would not venture to state that the emotional change observed in the patients during *pentamidine* treatment was caused by the drug, I am inclined to consider this possible; if this be the case, it constitutes a serious handicap to the therapy.

While considering the untoward effects of diamidine therapy, it must also be mentioned that the protein-poor diet given for several weeks is not exactly encouraging to the patient; it may also be partially responsible for the inhibition of bone marrow function.

SNAPPER mentioned that *stilbamidine* and *pentamidine* may affect the function of the kidneys, for which reason these drugs should not be given to patients with renal failure. The rapid development of uremia in one of our patients (case 6) may possibly have been caused by the treatment with stilbamidine.

I have attempted to compare the results of diamidine treatment in these 10 cases with those obtained in our previous 10 patients with myelomatosis, treated exclusively with roentgen irradiation. The difference is not very great and as myelomatosis is a disease with a highly variable course and the clinical results obtained by both methods uncertain, comparison is extremely difficult. In view of the severe side reactions which develop in most cases of diamidine-treated myelomatosis, I believe that the drugs should be restricted to cases which have become refractory to roentgen irradiation. This conclusion is not intended to belittle the theoretical importance of the discovery of the effect of the compounds on abnormal plasma cells.

SUMMARY

The results of treating 10 patients suffering from myelomatosis with *stilbamidine* and *pentamidine* are discussed. Certain side reactions are described, and these, it is suggested, restrict the more extensive use of the drugs in favour of roentgen therapy.

ZUSAMMENFASSUNG

Die Behandlungsresultate von 10 mit Stilbamidin und Pentamidin behandelten Patienten mit Myelomatose werden diskutiert. Gewisse Nebenwirkungen werden beschrieben und es wird angegeben, dass diese die ausgedehntere Anwendung der Drogen zu Gunsten der Radiotherapie beschränken.

RÉSUMÉ

Les résultats du traitement, par la *stilbamidine* et par la *pentamidine*, de 10 malades atteints de myélomatose sont discutés. Certaines réactions accessoires sont décrites et celles-ci ne sont pas en faveur de l'extension du traitement par médicaments mais au contraire en faveur du traitement par les rayons roentgen.

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FROM THE ROENTGEN DEPARTMENT (DIRECTOR: N. LAUGE HANSEN),
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SNAPPING FINGER

Roentgen Treatment and Experimental Production

by

W. Pagh Sperling

Snapping finger, which is a condition affecting the flexor apparatus of the fingers, is not at all uncommon. The most characteristic sign, from which the condition has derived its name in several languages, is that the flexion or extension of the affected finger does not occur as a smoothly gliding movement but is accomplished with a jerk. In French literature the disturbance is described as *doigt à ressort* and *blocage tendineux*; in English it is called *snapping finger* or *trigger finger*, and in German *schnellender Finger*, but apart from these descriptive terms and fairly uniform accounts of its surgical treatment much information is not available in the literature.

The cause of the obstruction to flexion or extension of an affected finger is a disproportion, limited in its extent, between the diameter of the flexor tendons and that of the sheaths in which these tendons glide on the volar side. A constriction of the sheath and/or some irregularity of the tendon are usually present. The constriction of the sheath may be due either to (1) swelling of sesamoid bones, (2) generalized swelling of a limited length of the peritendineum, or (3) contracted fibre bundles of the annular and cruciate ligaments in the tendon sheath. Most frequently, the irregularity of the tendon consists of a small swelling shaped like a spherical segment or a spindle involving the whole or part of the circumference of the tendon, or there may be a furrow worn into the tendon.

Microscopic examination of the thickening of the tendon reveals an increase in the fibrillar connective tissue with one or more sharply demarcated cystlike cavities and increased infiltration of lymphocytes,

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which must be interpreted as a slight, non-bacterial inflammatory reaction. If the sesamoid bones are also involved, microscopy shows reactive inflammatory changes in their periosteum.

These changes are observed at operation and are presumably manifestations of different stages of a pathologic process with a regular course of development.

The jerk of an affected finger is produced by a momentary arrest of the tendon, either because of thickening of the tendon or narrowing of the sheath, followed by a sudden movement when the resistance is overcome by the tension of the muscles. The still partially flexed finger is then extended or flexed to the full with great force and rapidity, possibly with a faint audible snapping sound. However, it may be impossible for the muscles to overcome the arrest, so that the movements can only be accomplished passively. If extension is completely arrested, a rupture of the extensor tendon must be considered in the differential diagnosis, but otherwise the diagnosis of snapping finger is not difficult.

The patients' statements as regards symptoms are often vague and curiously formulated, but generally they have a number of features in common, such as (1) spasmodically arrested, irregular movements of the finger, (2) pain on movements or merely on attempts at movements. The pain may be moderately severe and is located to the volar side of the finger or to the palm of the hand. Extension is often more painful than flexion. (3) Pain on first movements in the morning, decreasing when the finger has become active. (4) Tenderness on the flexor side of the finger, and (5) swelling in this region.

The condition may be incapacitating. Thus, a violinist who was unable to flex and extend the terminal phalanx of the right thumb and a lace-maker who could not grasp a bobbin were among our patients.

Examination of the patient reveals (1) local tenderness on the flexor side of the finger, usually at the level of one of the joints, (2) slight generalized swelling in the same region, (3) possibly swelling of the sesamoid bones, (4) characteristic jerky movements, (5) a localized irregularity of the tendon, and (6) tenderness of the muscles in the forearm, possibly of the medial or lateral epicondyle. If the thumb is affected, the jerky movements may be restricted to the interphalangeal joint, while the swelling, tenderness and constriction of the sheath are at the level of the metacarpo-phalangeal joint.

Slight swelling of the periosteum of the involved sesamoid bones, as compared with the unaffected side, is the only pathologic change noted on roentgen examination.

Some authors state that the condition is most frequent in the thumb and ring finger of the right hand, particularly in women. This was also

the case in my limited series, in which a large number of cases were localized to the thumb.

Without treatment the condition may become chronic. Not infrequently, the symptoms develop gradually in the course of some months and then persist for another few months, after which time they either slowly subside or become stationary.

Rest and heat treatment may be useful. Immobilization shortens the course of the disease. Conversely, frequent movements of an affected finger unquestionably accentuate the symptoms and prolong the course of the disease.

To the patient, six months or more seems quite a long time to be partially incapacitated, and an effective surgical treatment, which is easy to perform, has also been worked out. It consists in a longitudinal incision through the skin with section of the stenosing connective tissue of the peritendineum. If, after this, the function of the finger is still impaired, the tendon sheath is opened longitudinally, and part of the small tendon swelling is removed by an ovular incision, and cystlike cavities, if any, are drained. The tendon sheath is left open or closed crosswise; in about a week after the operation the disease will be cured, unless discomforting tenseness in the scar develops.

However, roentgen treatment constitutes a third possibility of therapy. According to SCHANZ a snapping finger may be cured by roentgen treatment. As far as I have been able to ascertain, this form of therapy has not been systematically employed in other institutions.

Since 1943 we have in this hospital used roentgen radiation in 30 cases of snapping finger in 26 patients. Of these patients, one had three, three had two, and 21 had one snapping finger. The age of the patients ranged from 13 to 75 years. The youngest patient but one was 41 years and the average age 59 years. This absolutely unselected series comprised 19 cases in women and 11 cases in men. A single regular trauma was stated as the cause by 5 patients, while the explanations given by the remaining 21 patients make it probable that the cause was prolonged overstraining of the flexor apparatus. In 16 cases the disease involved the thumb; of these, it was the thumb of the right hand in 12 instances. The remaining 14 cases were equally distributed on the four ulnar fingers of both hands.

Among the 26 patients, seven suffered from peritendinitis or allied disorders of the upper extremities, two from diabetes mellitus, two from arthritic changes of the wrist or finger joints, and four had Dupuytren's contracture. The duration of symptoms ranged from a fortnight to about 4 years, averaging about 8 months. The therapy consisted in roentgen radiation of the affected finger and the adjacent part of the palm. An initial series of 2—4 treatments was given daily or every

second or third day, and in some cases the irradiation was repeated after an interval of a fortnight. The patients did not have their fingers or hands immobilized; they attended to their normal work and did not receive any other form of therapy. The number of treatments given to each patient ranged from 2 to 9, averaging 4.5. The maximum period of irradiation, including the intervals, was 4 months, with an average of 4.5 weeks. Apart from 5 patients whom the radiation gave no benefit whatever as regards the restricted mobility of the finger, the average length of time between the first treatment to distinct recordable improvement of the condition was 28 days.

The total dosage to each affected finger varied from 500 r to 2,350 r, with an average of 1,150 r. In 3 cases transitory redness and subsequent exfoliation of the irradiated epidermis were seen, but these side effects caused no special inconvenience and were of no practical importance.

In all the 30 cases the following effects were observed: (1) Less pain on movement, (2) subsidence of generalized swelling, and (3) less tenderness.

Twenty-one of the 30 cases were completely cured, both subjectively and objectively. In 15 of these cases the thumb was involved. The sixteenth case of affected thumb had persisted for more than 6 months when roentgen treatment was instituted. During the course of treatment a complete arrest of the movements of the terminal phalanx developed in the latter case, due to blockage of the tendon at the level of the sesamoid bones at the metacarpo-phalangeal joint, but pain, swelling, and tenderness subsided after the treatment.

In the 14 cases of snapping ulnar fingers subjected to roentgen treatment the results may be summarized as follows. In six the subjective symptoms disappeared, and in eight pain and generalized swelling disappeared, but jerky or irregular movements still caused some discomfort. In all 14 cases a thickening of the tendon could still be felt. — Five of the eight non-cured patients were later subjected to surgical treatment, while the last three patients in whom the jerky movements persisted refused operation owing to the absence of pain in the affected finger.

All the patients, except one who later died of cardiac disease, were subjected to follow-up examinations. No recurrences were encountered and none of the patients had post-therapeutic discomforts, except those with complete arrest. In two cases symptoms developed in other previously untreated fingers.

Thus, the present study shows that in many cases local roentgen treatment may cure a snapping finger and in still more cases it may give some relief. Pain, tenderness, and swelling were reduced, whereas the impaired function of the affected finger was not always favourably affected, since complete arrest developed in three of the treated cases.

In particular, the results of roentgen treatment of snapping thumb are worthy of note. When the condition affects the thumb, it may possibly be regarded as a distinct disease entity. Here it is particularly the peritendineum and the sesamoid bones which are affected, while in case of the ulnar fingers it is almost invariably the tendon which is the site of the swelling or constriction.

The number of cases of snapping finger treated with roentgen radiation is as yet small, but as this therapy has proved effective, it is worth considering if it should not be given a trial in all cases with the exception of those in which a rapid cure is required. As a provisional standard treatment I suggest a dosage of 300 r, filtered with 3 mm Al or 0.5 mm Cu, given at a distance of 40 cm for 4 consecutive days; if necessary, the course of treatment may be repeated after 4 weeks. This dose of irradiation cannot compromise any subsequent surgical treatment.

In the majority of cases the condition seems to be due to a more or less protracted, relatively severe overstraining of a tendon and its sheath. A single trauma as the probable cause is rarely encountered; at least, the past histories of the patients do not seem to be very convincing in this respect.

The author, who has not previously suffered from the condition and who has not yet reached the period of life in which it is most frequently encountered, attempted to produce snapping fingers in himself in the following way:

(1) The little finger of the right hand was flexed at all three joints for periods during 72 hours against the resistance of a powerful spiral spring. A total of about 9,000 flexional movements were made, pure flexion being aimed at. Generalized swelling and tenderness of the flexor side of the finger appeared at once; in the course of a fortnight a characteristic snapping finger developed. It displayed all the aforementioned criteria, including jerky movements and palpable thickenings on both the terminal and proximal phalanges. Now, two months later the thickenings of the tendon can still be felt and jerks and audible snaps can be observed. No therapy has been used to relieve the condition, which is still under observation.

(2) Simultaneously, by means of combined extension-abduction movements, a similar overexertion of the tendons of the left extensor pollicis longus and the abductor pollicis longus was commenced. These particular movements were chosen because they are not ordinarily performed against any resistance and because snapping symptoms are accordingly unknown in this locality. The result of approximately 8,000 movements appeared immediately and became very pronounced after the lapse of 4 days in the form of (1) generalized swelling of the dorsal side of the proximal phalanx of the thumb, (2) redness in the same

region, (3) intense pain on movements, also when the joints were not subjected to strain, (4) tenderness of the same region, (5) visible jerks on extension of the metacarpo-phalangeal joint and on abduction of the carpo-metacarpal joint of the thumb, and (6) audible snaps on these two movements, whereas flexion and adduction caused pain but occurred without jerks and audible snaps. Now, two months later the symptoms still persist, although pain and tenderness on the aforementioned movements have diminished. The condition will now be treated with the suggested standard roentgen dosage.

(3) A total of about 9,000 flexions of the thumb of the right hand were carried out under the conditions described under experiment No. 1. A pure flexion of the metacarpo-phalangeal joint was aimed at, but simultaneous movements of the interphalangeal and carpo-metacarpal joints were allowed. Apart from a pronounced (and understandable) fatigue of the muscles, no symptoms developed.

(4) After the lapse of one month a combination of flexion and inward rotation of the metacarpo-phalangeal joint of the right thumb was attempted. The resistance was produced by stretching a spiral spring which was attached to the interphalangeal joint of the thumb. Thus, the terminal phalanx of the thumb was not subjected to any load. Approximately 40 movements per minute and a total of about 1,000 movements per hour were carried out. After about 8,000 movements tenderness on the volar side of the proximal phalanx developed and the experiment was then interrupted. After the lapse of 48 hours with progressive swelling and pain on movements a classical snapping thumb was evident.

Table

(1) Four ulnar fingers (14 cases)	Subsidence of subjective symptoms; swelling of tendon persisted		6 cases
	Complete arrest but no pain		2 »
	Still snapping movements	of no practical importance	3 »
		causing incapacity	3 »
(2) Thumb (16 cases)	Complete disappearance of symptoms		15 »
	Complete arrest of tendon but no pain		1 case
Total, 30 cases	Cured	21 cases.	
	Partially cured	3 »	
	Not cured	3 »	
	Aggravated	3 »	

Total dosage	500 r—2,350 r.
Single dose	150 r— 300 r.
Distance	30 cm—40 cm.
Filter	3 mm Al or 0.5 mm Cu.
Interval	1—2—3 days.

These experiments show that a single trauma to the flexor apparatus of the fingers is not necessary for the production of a snapping finger, and that numerous small movements, which individually are neither abnormal nor strenuous, may lead to the condition when the effects of these movements are summed up. Many persons engaged in industry, handicrafts, and domestic work are exposed to the risk of developing snapping fingers. It is possible that the condition develops more readily if it is preceded by a trauma to the subsequently affected region. So far, I have not checked this possibility by experiments.

SUMMARY

Roentgen treatment of 30 cases of snapping finger is reported. In the course of 4 weeks 21 patients became symptom-free, and the pain subsided in the remaining 9 cases. It is shown that a snapping finger may be produced experimentally in the course of a few days by vigorous exertion of the muscular system of the fingers.

ZUSAMMENFASSUNG

Es wird über Röntgenbehandlung von 30 Fällen von »schnellendem Finger» berichtet. Im Laufe von 4 Wochen wurden 21 Patienten beschwerdenfrei, in den übrigen 9 Fällen nahmen die Schmerzen ab. Es wird dargelegt, dass ein schnellender Finger durch heftige Beanspruchung des Muskelsystemes eines Fingers im Laufe weniger Tage experimentell erzeugt werden kann.

RÉSUMÉ

Note sur le traitement par rayons roentgen de 30 cas de tic digital. 21 malades furent débarrassés de tous symptômes dans le courant des 4 premières semaines et dans les 9 autres cas le mal s'était atténué. Il est démontré qu'un tic digital peut apparaître expérimentalement au bout de quelques jours par surmenage du système musculaire des doigts.

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FETAL DEATH DIAGNOSED ROENTGENOGRAPHICALLY BY THE PRESENCE OF GAS IN THE FETAL CIRCULATORY SYSTEM

Case Report

by

Kalevi Kettunen

The best known roentgenographic sign of fetal death in utero is SPALDING's sign, which is an overriding of the skull bones due to the shrinkage of the cerebrum. The significance of minor degrees of overlapping is not easy to assess, and BILLING (1) has shown that this sign may also manifest itself if there is evidence of an alteration of the level only and not of imbrication of the cranial bones. Some degree of overriding may occur in a normal fetus during engagement into a relatively small inlet and always occurs during moulding in labour. The radiological finding must always be carefully correlated with the clinical findings before final acceptance.

Other signs of fetal death are not so reliable. JUNGMAN (4) described accentuation of the lumbo-sacral curve as suggestive, but a true lateral view of the fetal spine must be obtained for this to be estimated. SZELLÖ (7) described pronounced spinal angulation as the earliest sign. According to HARTLEY (3) the dead fetus appears as if rolled up into a ball. This sign is fairly constant in fetal death, but it is also seen in numerous normal cases. A constant position of the fetal bones of the extremities as shown by control studies at intervals is recorded by THOMS (8) as a sign of death.

A new roentgenographic sign of intrauterine fetal death was described by ROBERTS (5) in 1944 and by DAVIDSON (2) in 1949. Both presented two cases demonstrating fetal death by gas in the fetal circulatory system. This sign is well shown in the following case.

Submitted for publication, June 12, 1951.

Case Report

H. H., aged thirty-six, para IV, was admitted to the hospital on March 19, 1950, with a diagnosis of maternal immunization to the Rh factor. Her expected date was March 30, 1950. Past history of measles and parotitis as a child as well as angina in 1936 and in 1937. The obstetrical history revealed two full-term living children delivered in 1939 and in 1942 without complications. The third pregnancy in 1947 was also allowed to go to full term, but the child died two weeks before delivery. The weight of the placenta was 800 gm. suggesting fetal hydrops.

During the present prenatal course blood group determinations of the mother, father and living children were performed. The mother was found to be Rh-negative, the father and children Rh-positive. The mother was referred to the hospital on March 17, 1950, because a rising titer of the antibody pointed to the presence of another offending fetus. On December 4, 1949, the titer of anti-Rh saline agglutinins was 1 : 2 and albumin agglutinins 1 : 8, and respectively on March 17, 1950, saline agglutinins 1 : 256 and albumin agglutinins 1 : 1,024. The fetal heart sounds were still heard.

On admission to the hospital a trace of albumin was noted in the urine, the temperature was 36.6° C., pulse 68 and blood pressure 140/90. Blood studies showed hemoglobin 74 per cent; red cells 3,660,000, white cells 8,600 (neutrophils 58.5 per cent, basophils 0, eosinophils 12 per cent, lymphocytes 26 per cent, monocytes 3 per cent, band forms 0.5 per cent); Wassermann and Kahn tests negative. The fetus appeared to be full term in the left occipito-anterior position. The fetal heart sounds were not heard.

The patient was referred to the roentgenological department on March 20, 1950. On the anteroposterior abdominal film (Fig. 1), the fetal skull was found to be symmetrical with no overlapping of the cranial bones. A roentgenogram in the left lateral projection (Fig. 2) showed a full term fetus with the placenta attached to the anterior uterine wall. Gas, well demonstrated, was noted in the great vessels of the inferior extremities and in the heart (Fig. 3). A diagnosis of fetal death was made.

The patient was discharged from the hospital on March 23, 1950, with instructions to return when labor started. She was readmitted on April 4, 1950, in early labor with the membranes ruptured. At this time the urine showed no albumin. The blood pressure was 125/80, temperature 36.5° C. and pulse 70. An abdominal examination revealed the fetus to be in the left occipito-anterior position with the presenting part fixed. Labor lasted twenty-two hours and ten minutes. A dead macerated fetus weighing 2,600 gm. was delivered. The placenta weighed 730 gm. The cause of death was attributed to erythroblastosis. The puerperium was normal and the patient was discharged on her fourth postpartum day.

Discussion

The origin of the gas in the fetal circulatory system is as yet not understood. ROBERTS (5) gave no explanation as to the source of the gas. DAVIDSON (2) was of the opinion that it is due to the decomposition of blood elements. He also believed that it must be a late sign of fetal death. In a case presented by him gas was not found on the same day as the fetal heart sounds ceased. A roentgenogram taken 11 days later showed the presence of gas. In one case of ROBERTS (5) fetal death was demonstrated within sixty-six hours after the absence of fetal movements were noticed. In the case reported above the fetus had not been

Fig. 1. Anteroposterior film of the abdomen. The fetal skull presents no abnormalities.

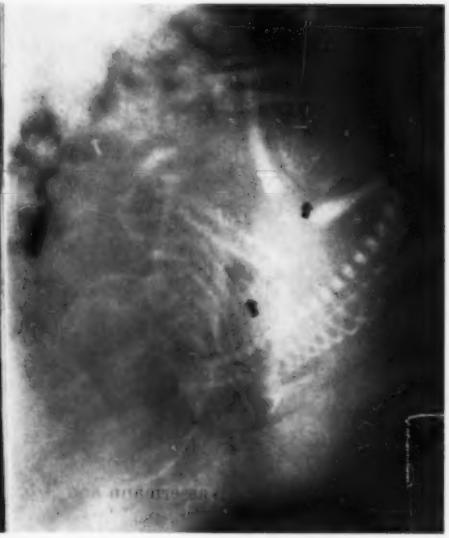

Fig. 2. Lateral view of the abdomen showing gas (arrows) in the fetal heart and in the femoral vessels.

Fig. 3. This roentgenogram demonstrates clearly the gas collection within the heart.

dead even as long as this when examined roentgenologically. Neither of the above mentioned investigators gave the blood group determinations; in the case presented here the mother was Rh-immunized. It is

probable that these factors are of significance for the presence of gas found in the circulatory system of a dead fetus.

Acknowledgement is hereby made to Dr. H. R. Nevanlinna, of the State Serum Laboratory, for the serological investigations in the case cited.

SUMMARY

Gas in the fetal circulatory system as a sign of intrauterine fetal death is demonstrated. The possibility of the Rh factor as a source of the gas is suggested. For the estimation of the gas in the fetal circulatory system a lateral roentgenogram of the abdomen is of importance.

ZUSAMMENFASSUNG

Luft im fötalen Kreislaufsystem als Anzeichen intrauterinen Fötustodes wird demonstriert. Die Möglichkeit, dass der Rh-Faktor die Luftbildung veranlassen kann, wird hervorgehoben. Für die Beurteilung der Luftmenge im fötalen Kreislaufsystem ist eine seitliche Röntgenaufnahme des Abdomen wichtig.

RÉSUMÉ

La présence de gaz dans le système circulatoire foetal est démontrée comme étant un signe de mort foetale intrautérine. L'opinion est émise que le facteur Rh serait à la source de ce gaz. Pour évaluer le gaz dans le système circulatoire foetal il importe de faire une radiographie latérale de l'abdomen.

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BOOK REVIEW

THORACIC AORTOGRAPHY WITH SPECIAL REFERENCE TO ITS VALUE IN PATENT DUCTUS ARTERIOSUS AND COARCTATION OF THE AORTA. By Gunnar Jönsson, Bror Brodén & Johan Karnell. 176 pp., 177 illustrations (70 radiograms and 102 diagrams). Suppl. 89 Acta radiol. Stockholm 1951. Sw. Kr. 30: —.

The work is based upon experiences gained at the 1st Roentgen department (Director: Dr. Gunnar Jönsson) of Södersjukhuset, Stockholm, Sweden.

The authors carried out their first thoracic aortographic examination in November 1947. They used a method based on that of RADNER, an opaque medium being injected into the aorta by means of a catheter inserted through the radial artery. Since then they have used the same technique with some modifications. In order to obtain more precise information on the value of the method, the authors have now collected their radiologic material and analyzed it from different points of view. The series consists of 25 cases of patent ductus arteriosus and 41 of coarctation of the aorta.

In a preliminary historical review, it is pointed out that most of the reports on thoracic aortography were published during 1948 and 1949. The reason is obvious. These were the years immediately succeeding the first successful operations on coarctation of the aorta, double aortic arch and similar abnormalities. The new field of surgery called for a form of examination giving more exact information on the aorta than that afforded by ordinary angiocardiographic methods.

In the following section the authors give a thorough description of their technical equipment and procedure. The injection is made with the aid of a pressure apparatus permitting the injection of 25 to 30 cc. of contrast medium per second. The details of the method of catheterization are given. They were worked out by HANSON. The risks involved in thoracic aortography are discussed.

Thoracic aortography is indicated when patent ductus arteriosus is suspected but the typical continuous murmur is lacking. The authors have also used the method in clinically typical cases to obtain a pre-operative conception of the anatomic conditions present. They drew two conclusions: 1) Thoracic aortography is necessary to ensure the diagnosis in cases with an atypical murmur. 2) In addition to its diagnostic value, thoracic aortography furnishes useful anatomic information in cases of patent ductus arteriosus.

In coarcation of the aorta, it is impossible, for several reasons, to obtain a distinct enough representation of the aorta by means of angiocardiography. Considering the amount of attention given to coarctation of the aorta since its surgical treatment has become possible, there have been few reports of the angiocardiographic examination of such cases.

Thirty-six of the authors' 41 cases were submitted to operation and in 34 an end-to-end anastomosis was performed. In 18 of the latter an aortographic examination was carried out both before and after operation.

In a typical coarctation, the deformity is not confined to the stenosis at the level of the ligamentum arteriosum. The whole thoracic aorta, especially the aortic arch, is more or less misshaped. The authors record their observations segment by segment, from the aortic bulb to the descending aorta, and give a detailed description of the varia-

tions in the aortic arch. It is important to study the distal section of the aortic arch, for operability and prognosis are largely dependent on its condition. The shape of the aortic arch in the pre-operatively examined cases is shown in thirty-six diagrams. The cases are divided into four groups. Group I, with a long and wide distal part of the aortic arch, was favorable from both an operative and prognostic point of view. Group II, with a long but narrow distal part, did not present any surgical difficulties, but had a worse prognosis. Group III, with a short distal part, was often more difficult to operate upon than the foregoing group. The prognosis was then dependent upon the width of the deformed area. In Group IV, with atresia of the distal part, it was impossible to make an end-to-end anastomosis.

The collateral vessels were studied as much as the picture-size used — 30 by 30 cm. — permitted. The upper intercostal arteries, leaving the descending aorta near the site of the stenosis, are of particular importance. They communicate with the arteries arising from the costocervical system and form powerful arterial trunks in the upper part of the mediastinum.

The operative result, *i. e.* the width at the site of the anastomosis, circulation of fluid in the aorta and collateral system, and signs of aneurysm in the field of operation, were studied in the post-operative radiograms. Finally, two cases of atypically situated coarctation, both inoperable, and two cases with both coarctation of the aorta and a wide patent ductus arteriosus, are described.

The main purpose of the book is to present instructive radiograms and the greater part of it, therefore, is given to the illustrations. A detailed legend is appended to each figure and the authors have attempted to give as clear a description as possible of the different types of patent ductus arteriosus and coarctation of the aorta.

Autoreview

BOOKS RECEIVED

We acknowledge with thanks under this heading books received for review, which we trust will be regarded as a sufficient mark of appreciation for the courtesy of the sender. The reviews of selected items will appear as soon as opportunity affords.

Atelektasen der Lunge. Von H. Alexander. Georg Thieme Verlag, Stuttgart 1951. DM 8.70.

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